WATER and RELATED LAND RESOURCES

EL RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN

NEW MEXICO

Elephant Butte Reservoir

SCS PHOTO 12-P992-11

PRELIMINARY
EARLY ACTION OPPORTUNITIES

A Report Based on a Cooperative Study by

THE UNITED STATES DEPARTMENT OF AGRICULTURE

and the

NEW MEXICO STATE ENGINEER

PREPARED BY
SOIL CONSERVATION SERVICE - ECONOMIC RESEARCH SERVICE - FOREST SERVICE
ALBUQUERQUE, NEW MEXICO 1970

USDA-SCS-PORTLAND, OREG. 1970

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EL RIO EN MEDIO SUBBASIN PRELIMINARY REPORT

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NEW MEXICO

PREFACE

This report is the third of four preliminary reports about the Upper Rio Grande Basin. It deals with water and related land resource problems and project opportunities in "the Middle River" area and suggests available United States Department of Agriculture programs that can be used to alleviate the problems. These are project opportunities that should be initiated in the next 15 years.

The four reports contain early action recommendations for (1) the Chama-Otowi Subbasin, (2) El Rio Arriba Subbasin (the "Upper River" area), (3) El Rio en Medio Subbasin (the "Middle River" area), and (4) Estancia Subbasin.

The final basin report will include early action recommendations compiled from an assessment of the project opportunities and appraisal of needs to support requests for early action basin-wide project authorization.

I. INTRODUCTION AND SUMMARY

Purpose, Objectives, Authority, and Scope of Study

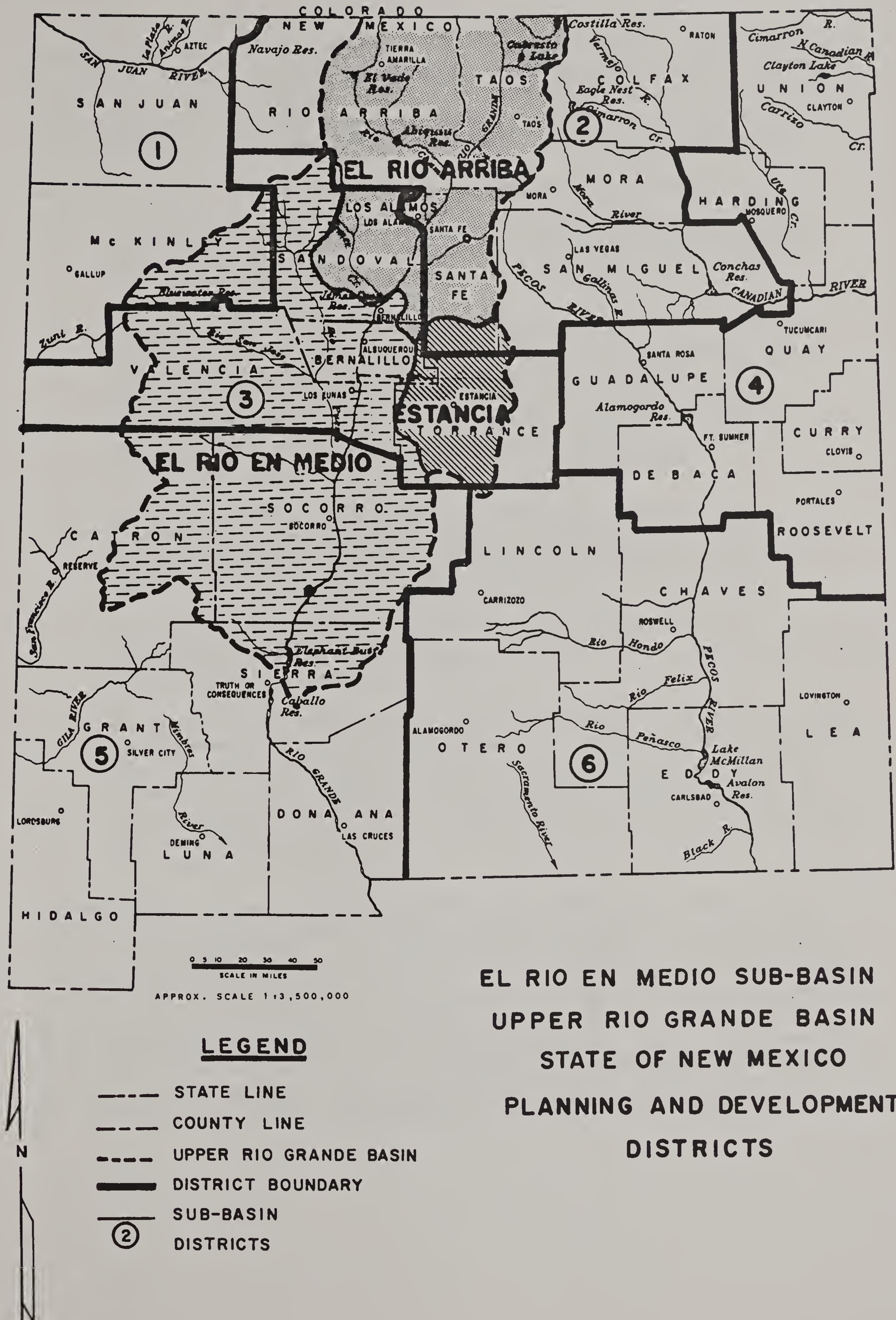
The purpose of this report is to summarize the problems, needs and development opportunities of water and related land resources that need immediate attention in the El Rio en Medio Subbasin of the Upper Rio Grande Basin, New Mexico.[1/] Identified are problems concerning the conservation and use of land and water. Various solutions are suggested through cooperation in programs of the United States Department of Agriculture and other federal and state agencies.

The office of the New Mexico State Engineer (the sponsoring and cooperating agency) requested the United States Department of Agriculture to conduct a study in the Upper Rio Grande Basin. This study has been made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended) which authorized the Secretary of Agriculture to cooperate with other federal, state and local agencies to develop coordinated programs. It is in compliance with the decision of the field advisory committee to release information on opportunities to solve problems that local people could launch immediately.

Emphasis is placed on opportunities for project-type developments through initiative of local sponsors. Developments under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566, as amended) are an example. Other opportunities such as farm and ranch development planning measures exist for individual and group developments. Eligible for United States Department of Agriculture technical and financial assistance are programs designed to cope with problems of land use and treatment, flood prevention, agricultural water management, municipal and industrial water supply, water quality management, recreation, and fish and wildlife.

In this cooperative survey report, it is recognized that social, institutional, legislative, and economic considerations may impede some recommended developments and increase the interest in others. These factors may establish the need for studies beyond the scope of this survey. These programs are treated only to the extent of discussing impacts, both adverse and beneficial, of recommended developments and their capability of meeting projected demands.

1/ The term "related land" as used here refers to land that is associated with water resources developments either through the effects of the land on the water resources, or the effects of the water resources and their developments on the land.



EL RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN
STATE OF NEW MEXICO
PLANNING AND DEVELOPMENT
DISTRICTS

Attention is directed to programs, projects and measures needed within the next 15 years. The report provides local people, the state of New Mexico, and federal agencies with possible courses of action (1) for the development, conservation, and use of the natural resources, and (2) to improve the economic and social opportunities for the people.

The basin study has the following five principal objectives:

1. To identify broad areas apparently feasible for land treatment with USDA project-type programs, and to appraise the economic effects of such practices.

2. To provide a technical basis for more effective coordination of USDA programs for watershed protection, flood prevention, agricultural water management, environmental quality, and related purposes with similar activities of local, state, and other federal agencies. Information would be assembled and developed on water and related land resource use and management, with particular regard to multiple-use.

3. To identify and describe the opportunities to assist in improving the agricultural economy of the basin through the use of small watershed projects under Public Law 566 that would be coordinated with other existing and projected developments.

4. To appraise the opportunities of meeting local water and related land objectives through existing or other USDA project-type programs as may become available.

5. To appraise the agricultural, rural community, and upstream watershed needs of the basin and to prepare a plan for the coordinated and orderly control and regulation, management and use of the water and related land resources to satisfy those needs to the extent feasible in the entire basin which includes such structural and associated land treatment measures as should be provided in the next 10 to 15 years.

The majority of these project measures can be developed under programs of the United States Department of Agriculture or programs in which USDA agencies can participate. The opportunities include (1) items on which project-type action is the best means of accomplishing the objectives, (2) programs to be carried out entirely by an agency of the U. S. Department of Agriculture, and (3) treatment measures to be carried out by land administering agencies and private landowners. All of the measures could come under authorities of the Resource Conservation and Development Act, Public Law 87-703. The projects and measures, where noted, are interrelated with project developments proposed by other agencies.

Problems Needing Early Action

Problems needing study and project action in the next 15 years can be grouped into seven general categories:

1. Water management problems including drainage, water availability, irrigation water management, and phreatophytes.

2. Floodwater, erosion, and sediment damage.

3. Field experimental work needs to be done to quantify the effects of vegetative manipulation.

4. Agricultural production hampered by (1) poor range management, (2) poor management and utilization of private forests, (3) inadequate marketing and processing facilities.

5. General economic problems such as high unemployment, low income, a high percentage of people on welfare, uneconomical operating units, tenancy, and lack of adequate credit.

6. Lack of adequate recreational facilities.

7. Environmental quality problems such as inadequate sewage and water systems and solid waste disposal.

Findings and Conclusions

1. Thirteen watersheds in the area have potential for development. Watershed investigation reports for these watersheds have been developed and are contained in the appendix of this report. Average annual costs for these watersheds would be $1,767,800 for 71 floodwater retarding structures and 360,000 linear feet of floodwater diversions. Average annual benefits would be $3,891,600. The overall benefit-cost ratio for the thirteen watersheds is 2.2 to 1. The proposed structures would control 1,372 square miles or 878,000 acres.

2. Community water systems are needed in 6 of 39 communities of over 100 persons population. Community sewage systems are needed in 21 of 37 communities. For the early action period, the costs for water and sewage are estimated:

Total cost	$100,046,000
Federal cost share	3,194,600
State financial assistance	240,000
Local peoples' share	96,612,000

   Analysis of groundwater resources indicates an adequate supply underlying 36 of the 39 communities. The communities of Acoma Pueblo, Tijeras, and Magdalena need detailed studies to determine if adequate groundwater can be developed for the 1980 projected population. Many of the communities are located in a declared water basin and must comply with the regulations applying to the appropriation and use of underground water.

3. Population increase will increase municipal and industrial water needs. The population by 1980 is estimated to be 599,550 as follows:

Rural	33,120 (8% increase)
Municipal	566,430 (68% increase)

   The average daily requirement and depletion of water by municipalities and industries by 1980 is estimated to be:

	Average daily requirement (acre-feet)	Average daily depletion (acre-feet)	Increase requirement (acre-feet)	Depletion %
Municipal	330.30	199.92	106	131
Rural	6.10	4.07	23	17
Industrial	181.24	26.42	-	-
Power	1801.67	36.12	-	-

4. Fourteen resource conservation and development type studies are proposed. These project measure suggestions include intensive land treatment, expanded agricultural production and marketing, associations for production and marketing, community facilities, transportation, and recreation facilities.

5. Vegetative manipulation is needed to increase the water yield but more experimental data is needed in order to quantify the effects.

6. Irrigation system improvement is needed on 60,000 acres of irrigated cropland. Associated with this are 28,000 acres of land that need subsurface drainage.

7. Early action land treatment needs are identified as:

Critical area management	1,785,000 acres
Good range management	2,913,000 acres
Abandoned cropland treatment	11,000 acres
Pinyon-juniper control and management	2,140,000 acres
Sagebrush control and management	78,000 acres
Mesquite control	75,000 acres
Chaparral control and management	24,000 acres
Rabbit brush control and management	36,000 acres
Bottomland vegetation control and management	43,000 acres
Commercial forest land management	226,000 acres

Approximately 50 percent of the subbasin's soils are subject to extreme erosion when vegetative cover is disturbed.

The total estimated cost for land treatment in the subbasin is $74,685,000 including $11,350,000 on thirteen watersheds identified for the early action program. This cost converted to an annual equivalent is $6,600,000 and produces estimated average annual returns of $14,680,000. This land treatment activity will create an additional 560 man-years of employment for the area annually.

8. Recreation visitor day use is projected to double by 1980. Existing and planned recreational developments will be adequate to satisfy the estimated needs of the subbasin for 1980.

9. National Forests (Santa Fe and Carson) are significant in the area. Project work inventories (listing of non-recurrent work) identify 12 distinct types of resource conservation and development needs. The total estimated cost for this work is $50,800,000.

10. The early action opportunities identified in this report (primarily for watershed protection and flood prevention on thirteen watersheds) would have average annual costs of $8,367,800, would produce estimated average annual benefits and returns of $18,571,600 and provide 704 average annual man-years of additional employment. This additional employment would add an estimated $2,816,000 annually to the economy of the area.

Erosion scars on Acoma Creek Drainage SCS PHOTO 12-P992-9

Description of Study Area

Physical Features

El Rio en Medio Subbasin of the Rio Grande Basin is located in Central New Mexico. "El Rio en Medio" is the Spanish language expression for the "Middle River". The area includes all or portions of McKinley, Torrance, Valencia, Bernalillo, Socorro, Catron, Rio Arriba, Sierra, and Sandoval Counties. The study area is about 170 miles long and 106 miles wide. It is bounded on the east by the west slopes of the Jemez, the Sandia, Manzano, and San Andres Mountain ranges and on the west by the Continental Divide. The San Felipe stream gage on the Rio Grande is the north boundary. The gage is located 21 miles north of Albuquerque at the San Felipe Indian Pueblo. The subbasin extends south to Elephant Butte Dam.

The drainage pattern is to the south. Sea level elevations range from 5,120 feet at the San Felipe stream gage and about 4,600 feet at Elephant Butte to about 11,390 feet on Mount Taylor in the San Mateo Mountains.

There are about 11,802,200 acres (18,161 square miles) in the study area. Approximately 17 percent of this land is privately owned, 16 percent is state land, and 9 percent is Indian land. Fifty-eight percent of the land is administered by federal agencies [16 percent (1,561,000 acres) Forest Service, 37 percent Bureau of Land Management, 5 percent National Parks, military reservations, and wildlife reservations].

The subbasin includes many small communities and a few larger cities. The larger cities are Albuquerque, Bernalillo, Belen, Los Lunas, and Socorro. Of these, Albuquerque is the largest and is the main trading center of the area.

The topography varies from steep, very rough, mountainous terrain to nearly level mesas and broad flat river bottoms.

There are about 95,000 acres of land under irrigation systems, 804,000 acres of commercial forest, 3,819,000 acres of woodland, 1,237,000 acres of brushland, 5,269,000 acres of grassland, 80,000 acres of bottomland vegetation, and 232,000 acres of land for miscellaneous use in the subbasin.

The subbasin includes parts of the (1) Southern Rocky Mountains Physiographic Province, (2) the Navajo section of the Colorado-Plateaus Physiographic Province, and (3) the Mexican Highland and Sacramento Section of the Basin and Range Physiographic Province.

The soils are closely related to the geologic patterns. Most soils are immature and have physical characteristics obviously influenced by the associated rock formations. Rocks range in age from Recent to Precambrian and include sedimentary, metamorphic, and igneous types.

Soils range from:

dense clays developing on soft shale to --

SCS PHOTO 12-P993-4

-- active sand dunes blown from stream channels

SCS PHOTO 12-P1001-8

Badlands west of Bernalillo. Sediment source areas like this help fill stream channels and muddy irrigation water. SCS PHOTO 12-P990-6

The soils occurring in the New Mexico-Arizona Plateaus and Mesas Land Resource Area (see Land Resource Area Map) play a most important part in the basin economy and environment. These soils are developing primarily in the highly erosive materials of the Santa Fe geologic group and contribute a large percent of the damaging sediments of the subbasin.

The subbasin is traversed by Interstate Highways 25 and 40 and U. S. Highways 380 and 60 which are the main arteries of travel. Numerous state and county highways provide access to most of the study area.

The Atchison, Topeka and Santa Fe Railroad ties the study area to eastern and western states.

The climate varies from severe winter weather with heavy snowfall in the high mountains to a temperate semi-arid climate in the lower regions. Recorded temperatures range from a high of 106 degrees to minus 40 degrees Fahrenheit.

The average annual precipitation above the 8,500 foot elevation is about 18 inches of which about half is snowfall and half is summer rainfall. At lower elevations the annual precipitation ranges from about 6 to 12 inches and usually falls during summer thunderstorms. (For more climatic data see table 1).

Table 1, Typical climatic conditions by land resource areas in the El Rio en Medio Subbasin, New Mexico, for length of record

Station	Length of record (years)	Elevation (feet)	Precipitation: Mean annual (inches)	Precipitation: October-March inches	Precipitation: October-March % of annual	Mean annual temperature °F.	Minimum temperature °F.	CIR 2/ (inches)	Frost-free period From	Frost-free period To
NEW MEXICO AND ARIZONA PLATEAUS AND MESAS LAND RESOURCE AREA (WP)										
Cuba	22	7045	13.79	8.64	62	46.5	-40	1.11	6/7	9/20
Regina	1/	7450	15.86	6.76	42	45.4	-30	-	6/3	9/25
Johnson Ranch	16	7200	10.53	4.19	39	-	-	-	-	-
Thoreau	7	7120	10.29	4.12	40	-	-	-	-	-
Lee Ranch	10	7200	8.25	2.85	34	-	-	-	-	-
Grants	14	6520	8.83	2.80	31	-	-	1.64	5/21	10/12
San Fidel	38	6100	9.85	2.83	28	51.5	-20	1.64	5/2	10/18
Laguna	48	5815	9.86	3.06	31	53.4	-20	1.64	5/25	10/20
Hickman	13	7890	8.68	3.22	37	-	-	-	-	-
Augustine	1/	7025	10.51	3.21	30	47.9	-26	-	5/25	9/30
Magdalena	56	6556	11.86	3,43	28	52.1	-21	-	5/1	10/15
Danley Ranch	21	6800	9.75	2.87	29	49.6	-12	-	-	-
SOUTHERN DESERTIC BASINS PLAINS AND MOUNTAINS LAND RESOURCE AREA (SD)										
Bernalillo	36	5060	8.41	3.29	39	54.5	-18	1.95	5/3	10/10
Albuquerque	1/	5314	8.13	2.86	35	56.6	-13	2.01	5/3	10/12
Los Lunas	63	4885	8.07	2.82	34	-	-	2.11	5/3	10/15
Belen	17	4800	7.01	2.73	28	56.6	- 7	2.22	4/22	10/17
Socorro	1/	4617	8.75	2.62	29	58.4	-16	2.11	4/14	10/28
Bosque del Apache	1/	4520	7.79	2.54	31	58.2	- 9	2.10	4/13	10/24
Engle	29	4770	9.14	2.61	28	-	-	-	-	-
Elephant Butte Dam	76	4576	8.55	2.53	29	61.2	- 5	2.57	3/27	11/12
PECOS-CANADIAN PLAINS AND VALLEYS LAND RESOURCE AREA (CP)										
Bingham	21	5453	9.07	2.77	31	55.5	- 8	-	5/3	10/22
ARIZONA-NEW MEXICO MOUNTAINS LAND RESOURCE AREA (RM2)										
Marquez	19	7620	11.79	3.97	33	-	-	-	-	-
Kelly Ranch	16	6700	13.86	4.08	29	-	-	-	-	-
Rienhardt Ranch	10	5450	8.05	2.17	28	-	-	-	-	-

1/ Normal based on 1931-1960 records
2/ CIR - Consumptive Irrigation Requirement

Source: Consumptive Irrigation Requirements of Selected Irrigated Areas in New Mexico, NMSU Ag. Exp. Sta. Bulletin 531

Land use varies from --

-- rich bottomland irrigated farms to -- SCS PHOTO 12-P991-10

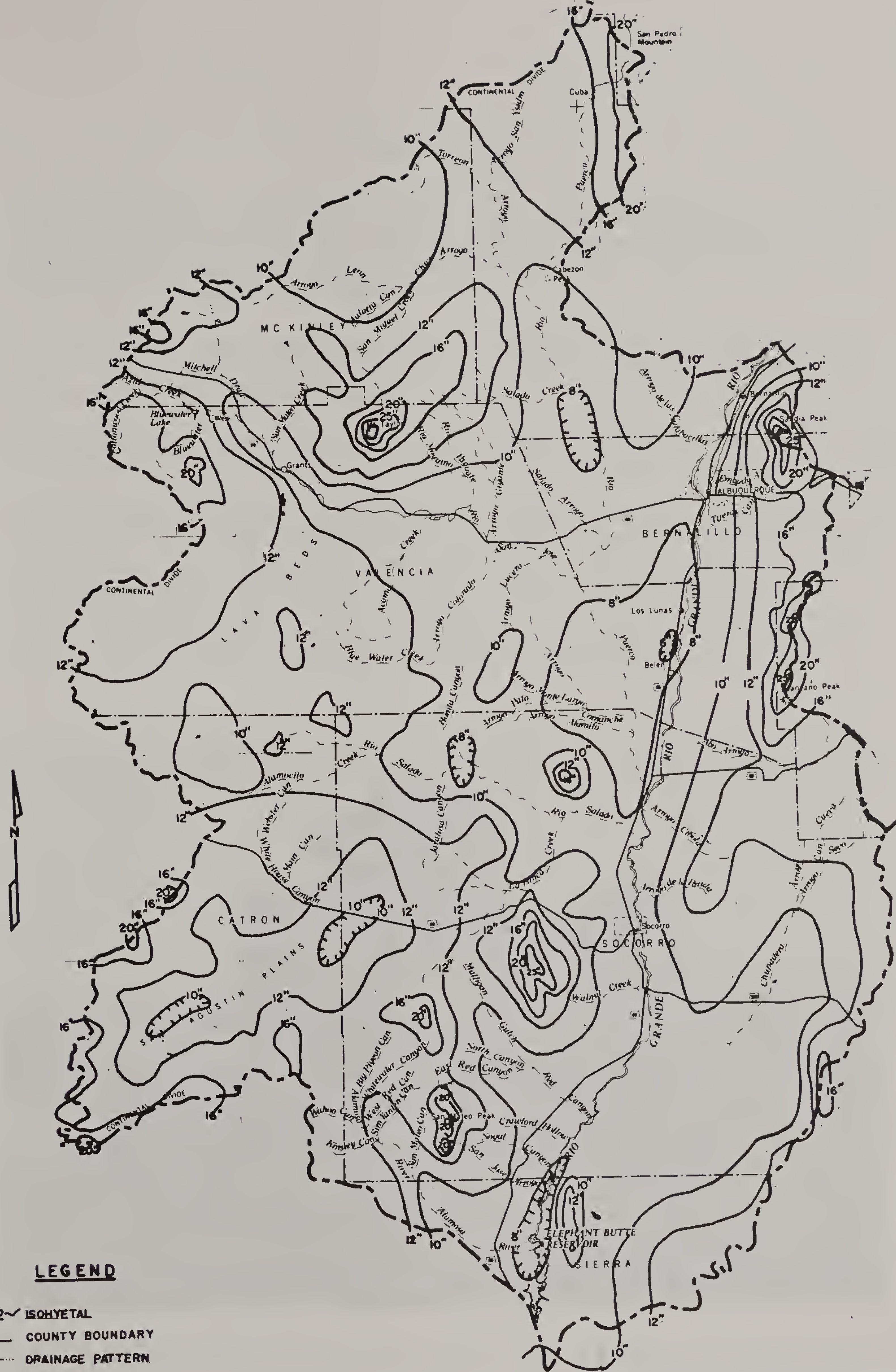
-- sparsely vegetated rangeland SCS PHOTO 12-P938-6

Sparse vegetative cover caused by a combination of past unwise land use and the arid climate contributes to severe erosion and sediment problems in the lower elevations of the study area. The "carrying capacities" on range lands vary from 36 to 320 acres per animal unit. The 95,000 acres of irrigated lands are a big part of the "life blood" of the subbasin and make a significant contribution to the economy. Present water supplies are fully appropriated.

Some of the main tributaries to the Rio Grande in the subbasin are: Tonque, Las Huertas, Tijeras, Abo, Hell's Canyon, Canyon Sales, Pinos, Cibola, and Calabacillas Arroyos; Rio Puerco and Rio Salado; Cupadera, Mulligan's Gulch, Nogal, and San Sosa Arroyos; and Alamosa River.

There are thousands of acres of vegetation, including phreatophytes, that might be manipulated to increase water and forage yields. Field experimental work will be necessary in order to determine the actual effect of this vegetative manipulation.

Rio Puerco (Dirty River) carries a heavy sediment load and supports dense areas of phreatophyte vegetation, primarily salt cedar. RBFP PHOTO



LEGEND

- ISOHYETAL
- COUNTY BOUNDARY
- DRAINAGE PATTERN
- SUB-BASIN BOUNDARY
- PAVED HIGHWAY
- CITY

NORMAL ANNUAL PRECIPITATION

RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN

Social Features

This area is one of the oldest continuously occupied areas in the United States containing the Sandia, Laguna, Acoma, and Isleta Pueblos and the Canoncito and Acoma (Navajo) Reservations. Some of the first Spanish settlements in New Mexico are located in the area. The area was first explored by Coronado beginning in 1540.

At the present time, there are three predominant ethnic groups in the area: (1) the native Indian, (2) descendants of Spanish settlers, and (3) people of Anglo extraction.

The population within this area is about 366,900. The percentage of the population on public welfare is above the average percentage for the state.

Public welfare programs exist to aid in training welfare recipients in some areas. Two federal programs designed to combat "hard core" unemployment are the Area Redevelopment Act (ARA) and the Manpower Development and Training Act (MDTA). Both gave the New Mexico Employment Service the responsibility of identifying occupational training needs and the selection of trainees. The choice of training sites and the actual training are functions of the State Department of Education.

Ruin of old church in Engle, New Mexico, east of Truth or Consequences

SCS PHOTO 12-P992-16

New Mexico Counties that are economically depressed and all Indian reservations and pueblos have been designated as eligible for assistance under ARA.

This entire subbasin is within the Four Corners Economic Development Region and includes parts of New Mexico Planning and Development Districts 1, 3, and 5.

Land Resource Areas

The individual land resource areas (LRA) are geographical areas characterized by particular patterns of soil (including slope and erosion), climate, elevation, water resources, land use, and type of agriculture. There are five land resource areas represented in this subbasin as follows:

1. New Mexico and Arizona Plateaus and Mesas (WP) - This "LRA" is located in the western part of the study area at altitudes of 5500 to 7000 feet above mean sea level. The vicinities of Grants and the San Agustin Plains are typical of this "LRA". Shrubs and short grass are the main vegetation; however, pinyon and juniper trees occupy the shallow soils and higher elevations. Most of the land is used for grazing except scattered areas of

New Mexico and Arizona Plateaus and Mesas Land Resource Area. Acoma Pueblo (Sky City) in distance SCS PHOTO 12-P992-8

LEGEND

-----------	DRAINAGE PATTERN
— — —	COUNTY BOUNDARY
———	PAVED HIGHWAY
—— —	SUB-BASIN BOUNDARY
RM	SOUTHERN ROCKY MOUNTAINS
HV	HIGH INTERMOUNTAIN VALLEYS
WP	NEW MEXICO-ARIZONA PLATEAUS & MESAS
SD	SOUTHERN DESERTIC BASINS PLAINS AND MOUNTAINS
RM2	ARIZONA-NEW MEXICO MOUNTAINS
CP	PECOS-CANADIAN PLAINS AND VALLEYS
o	CITY

LAND RESOURCE AREAS

RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN

irrigation along the Rio San Jose and the Puerco which produce climatically adapted field crops. The area is characterized by gently sloping mesas and plateaus surrounded by precipitous cliffs.

2. Southern Rocky Mountains (RM) - This "LRA" occurs in the extreme northern tip of the study area. It is characterized by steep mountains dissected by narrow stream valleys. High plateaus and steep-walled canyons are common. Altitudes range from 6000 to 10,600 feet above mean sea level. Upper mountain slopes support forests of mixed conifer, spruce, fir, and aspen, while pinyon-juniper woodlands and sagebrush occur at lower elevations. The high elevations are utilized for summer grazing, forestry products and recreation. The lower elevations are used for range. Irrigated fields of native hay and alfalfa are scattered along bottomlands at lower elevations.

Southern Rocky Mountains Land Resource Area. Photo taken near Cuba, New Mexico

SCS PHOTO 12-P990-16

3. Southern Desertic Basin (SD)- This "LRA" comprises a large part of the study area. It is located along the Rio Grande at elevations of 4500 to 6500 feet. It is part of a large desert "LRA" that extends from the southwestern corner of New Mexico to the Big Bend Country in Texas. Desert shrubs and short grass cover much of the area, but there are open pinyon-juniper woodlands at high altitudes. Livestock production is the main use and carrying capacities are generally low. Irrigation projects occur along the Rio Grande. Alfalfa, vegetables, and orchards are the main crops.

Southern Desertic Basins Land Resource Area. Photo taken east of Elephant Butte Reservoir. SCS PHOTO 12-992-14

4. Arizona and New Mexico Mountains (RM2) - This mountainous "LRA" is similar to the Southern Rocky Mountain area except average annual temperatures are slightly higher. It is represented in the subbasin by the northern tip of the Sandias, the Ortiz, and the Cebolleta Mountains. The higher elevations (about 5 percent of the area) are in forests of spruce, fir, and ponderosa pine while the lower elevations are covered with pinyon and juniper trees, chaparral, and mixed grasses. Most of the area is rough and steep and is used for harvest of forest and woodland products, livestock production, and recreation.

Arizona and New Mexico Mountains Land Resource Area. Photo taken near Grants, New Mexico FS PHOTO

Pecos-Canadian Plains and Valleys Land Resource Area. Photo taken near Mountainair, New Mexico SCS PHOTO 12-P962-6

5. <u>Pecos-Canadian Plains and Valleys (CP)</u> - The subbasin includes a small part of this gently sloping "LRA" in the eastern part of Socorro County. Elevations range from 5,000 to 6,000 feet. Most of the slopes of this dissected high plain are gentle or rolling, but bands of steep slopes and rough broken land border the stream valleys. This "LRA" is primarily grassland with scattered woodland and is used for livestock production.

Uses Of Report

This preliminary report is intended to summarize the present and projected problems and needs and to present short-range development opportunities that local people could initiate at an early date. It informs local people of the Department of Agriculture programs of assistance available to help solve their problems. Possible uses of the report are:

1. To help soil and water conservation district boards of supervisors revise and up date their long-range programs of work and to provide them with objectives and goals for their annual plans of work.

2. To inform landowners and operators of resource problems, of courses of action for solving these problems, and of the probable results of courses of action.

3. To indicate to business and community leaders how local action programs, utilizing natural resources, can support new industry, expand business activity, and encourage growth in the economy.

4. To help county commissioners, and the State Highway Department evaluate development trends which may serve as a basis for projecting current and future highway needs.

5. To assist state and county action groups to identify rural problems and suggest ways to more completely develop the natural, human, economic, and social resources.

6. To identify for state and federal agencies, opportunities for coordination of efforts to make maximum contributions toward the conservation, development, and use of natural resources.

7. To provide regional organizations (Economic Development Districts, Four-Corners Regional Development Commission, Councils of Governments, etc.) with factual data which could be considered for program coordination and action by such organizations.

8. To provide land use planning and zoning entities with factual data to guide their planning and decision-making activities.

Participating Agencies

The study is in accordance with the Memorandum of Understanding, dated April 15, 1968, between the Administrator of the Soil Conservation Service, the Chief of the Forest Service, and the Administrator of the Economic Research Service. Representatives of these agencies constitute a field advisory committee to oversee the conduct of the survey. Specialists and technicians from these agencies and the New Mexico State Engineer Office constitute the field party which gathered and evaluated the data in this report.

Acknowledgment to Others

Many state and federal agencies, in addition to the Department of Agriculture and the State Engineer of New Mexico, have provided data and assistance for this report. Significant contributions have been received from private individuals, business firms, the state's universities, and retired professional people.

Existing Water and Related Land Resource Projects and Programs

Agencies of the Departments of Agriculture, Interior, and Army and the State of New Mexico have existing projects and programs which are designed to meet some of the needs for conservation and utilization of El Rio en Medio's water and land resources.

Soil Conservation Service

Public Law 566 offers opportunities for dealing with small watershed protection and flood prevention problems. These are discussed in the section on watershed investigation reports.

Public Law 46 - The 74th Congress enacted Public Law 46 which established a national soil and water conservation policy creating the Soil Conservation Service. It directed the Soil Conservation Service to develop a program to produce results in preventing soil and water wastage and in reducing flooding and sediment hazards. To effectively carry out this responsibility, technical services are available to land owners in organized soil and water conservation districts to assist in planning, designing, and applying conservation practices.

Public Law 1021, Great Plains Conservation Program - The purpose of this program is to expedite needed changes in land use and the application of necessary conservation treatment to land. The legislation authorizes cost sharing to facilitate such changes and is applicable in the Torrance and Socorro County portions of the El Rio en Medio area.

Public Law 87-703, Resource Conservation and Development - This authority of USDA is available to local sponsorship that is willing to combine local determination with local leadership and self government toward the objective of effecting conservation and economic opportunity through development of their area's natural resources.

Forest Service

National Forest Development and Multiple-Use Program - National Forests are managed under principles of multiple use to produce a sustained yield of products and services as authorized and directed by the Multiple Use Act of June 12, 1960. These principles provide for the management of forest resources so that they are utilized to best meet the needs of the American people. These forest resources are water, timber, range, recreation, and wildlife habitat.

Water Resources - As regulators of water flows, National Forest watersheds are managed in accord with two principal objectives: (a) protection of the watershed to preserve and improve water quality, (b) management of the watershed to increase water yield in harmony with other resources and uses.

Timber Resources - The goal for the National Forest system is annual harvest on a sustained yield basis to meet the projected need for timber which the National Forests will be expected to supply. Management objectives to meet this goal are: (a) protect, develop and utilize the timber resource so it will contribute its greatest social and economic benefits on a sustained yield basis in harmony with protection, development, and use of other National Forest system resources and activities, (b) improvement of timber stands, (c) reforestation of non-stocked or poorly stocked lands, (d) maintain proper stocking and growing conditions in young stands through timely timber stand improvement measures, and (e) reduce fire, wind, insect, and disease losses through proper harvesting, and direct control.

Range Resources - An estimated 930,000 acres of National Forest system lands are suitable for the grazing of livestock.

Objectives for managing the range resource are: (1) produce the maximum amount of forage on a sustained yield basis, consistent with other uses and demands, and (2) maintain a healthy livestock industry by (a) restoring depleted ranges to full production, (b) managing in accordance with proven methods and techniques, and (c) encouraging improvement and proper use of adjacent and intermingled rangelands.

Stable watershed RBFP PHOTO

Misused watershed SCS PHOTO 12-P938-7

Forest Products RBFP PHOTO

Processing Mill RBFP PHOTO

Abuse (right) versus proper use of the range resource RBFP PHOTO

Good stock watering facilities make for better use of range RBFP PHOTO

Brush control with ecological, aesthetic, and wildlife consideration

RBFP PHOTO

Cholla cactus - an undesirable range plant

FS PHOTO

Recreation Resources - The recreational potential of the National Forest land is relatively unlimited. Presently, with few exceptions, the entire National Forest area is open to hunting, fishing, riding, and hiking.

Projected population growth will add to the present intense use of National Forest recreational facilities. It is the policy of the Forest Service to provide facilities for visitors to the National Forests. Intensive recreation management composite plans select areas of high recreation value so they can be managed and developed to balance the needs of the people with the capacity of the land. These sites will be developed dependent on demands and availability of funds. If recreation demands develop beyond those projected, site selection criteria might be altered to make additional area available.

Wildlife Resources - The long-range objectives of wildlife management are to provide and maintain an environment conducive to the fullest production of fish and wildlife in harmony with the uses and management of other resources. Vegetative-type conversion may change the environment. Such projects will be designed and executed giving full recognition to wildlife needs. Extensive-type conversion project financing will include provisions for inventories prior to beginning of operations. Areas found important to wildlife will be given special consideration for protection and enhancement. Forest Service policy and guidelines will govern allowances for wildlife cover, forage, and protection on all type conversion projects on National Forest lands.

Fire Control - Control of wildfire is basic to the protection of all vegetative and wildlife resources. Fire protection planning must anticipate greater risks as the forests annually accommodate more users.

Fire damage is frequently followed by disastrous insect and disease invasion on forested areas. It usually results in erosion, increased sediment and floodwater production, sediment deposition, and destruction of forage required by both livestock and wildlife. Serious economic losses are incurred by forest industries, forest dependent communities and range operators.

Prevention and prompt suppression of potentially disastrous range or forest fires are now, and will continue to be, important facets of resource and watershed management. Prescribed burning is coming to be recognized as a management tool in certain cover types and will be used more extensively as methods and procedures are better understood. However its use depends upon the user's ability to use without harming the air quality.

Other Department of Agriculture Programs

Agricultural Conservation Program administered by the Agricultural Stabilization Service is the program through which the United States Department of Agriculture provides a cost share for landowners and operators to install conservation practices that are difficult and expensive, but which have enduring benefits to the economy, promote proper land use, and effect efficiencies and resource savings.

Farmers Home Administration is a lending agency of the United States Department of Agriculture and provides credit and management aid to people in rural areas. Loan programs available to those who are unable to obtain loans from private sources are: (1) farm ownership loans, (2) farm operating loans, (3) housing loans, (4) under Title III, Economic Opportunity Act of 1964, FHA provides assistance loans up to $2,500 for establishing profit-making enterprises, (5) soil and water development loans. (Under this program, groups of farmers or urban dwellers may form an association and obtain loans for development of water and sewer facilities). (6) Recreation development loans, (7) loans to grazing associations, (8) loans to local organizations to finance the local share of costs of carrying out Public Law 566 works of improvement.

Cooperative State-Federal Forestry Programs - The U. S. Forest Service and the New Mexico State Forestry Department are involved in three state-federal cooperative forestry programs: (1) fire control, (2) forest management, and (3) tree planting. The New Mexico State Forestry Department is providing fire protection on state and private lands in the state. The U. S. Forest Service provides fire protection for state and private lands inside and immediately adjacent to National Forest boundaries under contractual arrangements with the State Forestry Department.

Reservoir or Other Local Protection Projects

Corps of Engineer Projects

The Rio Grande Floodway was authorized by the Flood Control Acts of 1948 and 1950 as a part of the comprehensive plan of development and a joint undertaking by the Corps of Engineers and the Bureau of Reclamation to provide flood protection and major drainage works along the Rio Grande in New Mexico. The plan consists of a system of levees operating in conjunction with river channel rectification work and rehabilitation of drainage systems to provide flood protection to developments along the Rio Grande. The middle valley floodway extends from Cochiti to San Marcel, a distance of about 130 miles, and consists of the Cochiti to Rio Puerco reach (which includes the completed Albuquerque unit) and the Bosque del Apache reach.

The Albuquerque Diversion Channels Project was authorized by the flood control act of 1954. This project is designed to provide protection to the city of Albuquerque from floods originating along the west slopes of the Sandia Mountains and the mesa east of the Rio Grande. The project consists of two diversion channels and appurtenant works located on high ground east of and generally parallel to the valley. The North Channel (completed in 1968) drains northward and intercepts flood flows from numerous waterways between Interstate 40 and Alameda, a

distance of about 10 miles. The South Channel (under construction) will direct flood flows south of Highway 66 to the Rio Grande through an outfall channel at Tijeras Canyon. This channel is about 6.3 miles long.

Bureau of Reclamation Projects

Elephant Butte Dam is the southern boundary of the study area. The dam was constructed in 1916 by the U. S. Bureau of Reclamation. The stored water is used for power development and irrigation in New Mexico and Texas. The Bureau of Reclamation currently operates and maintains the works of the rehabilitated Middle Rio Grande Conservancy District.

Projects of Conservancy, Irrigation, or other Districts

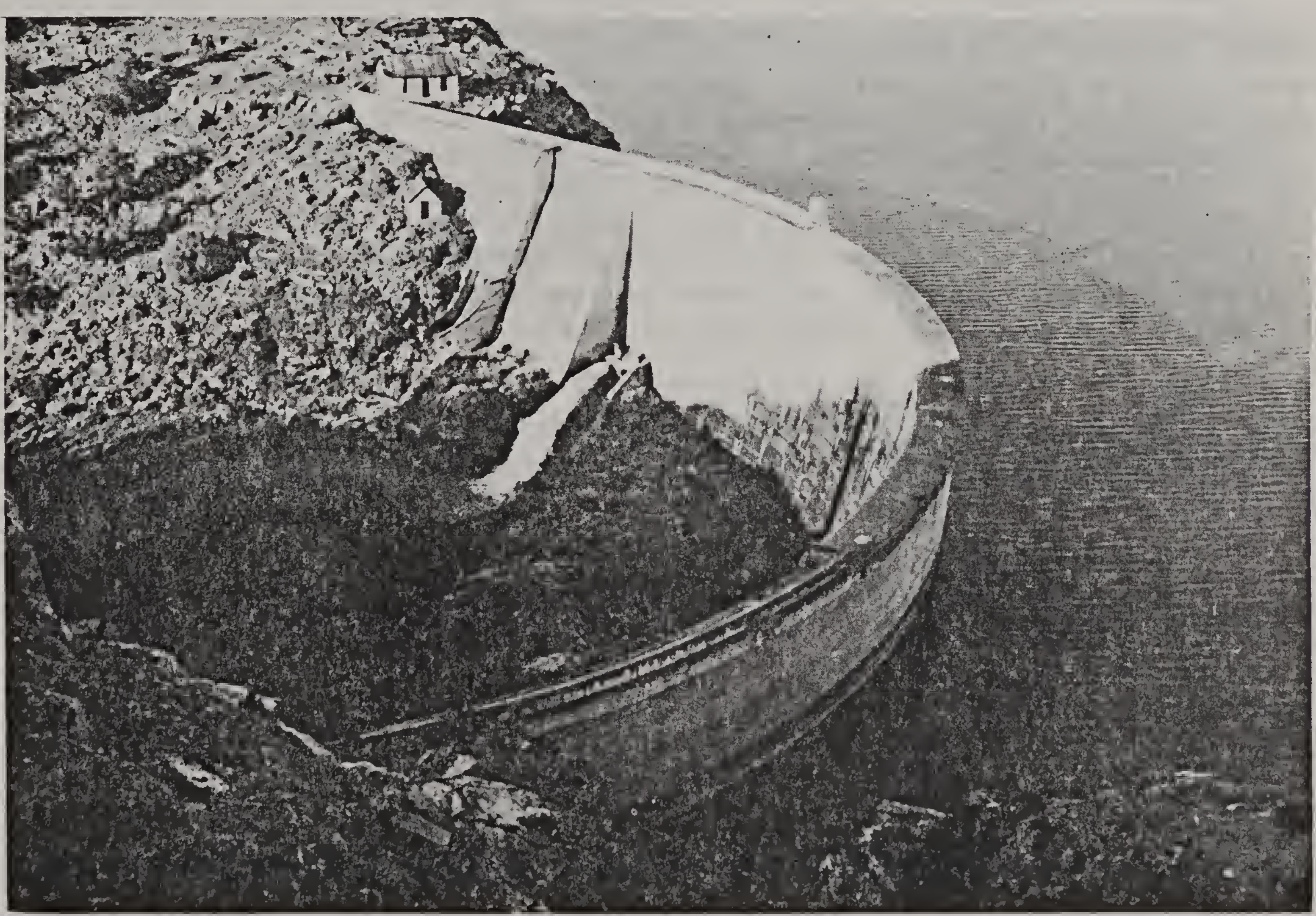
The Middle Rio Grande Conservancy District was organized in 1925 to rehabilitate and operate an irrigation water delivery and drainage system in the middle Rio Grande Valley. The district is operating one storage reservoir, four diversion dams, five drainage wells, 780 miles of canals and laterals, 393 miles of open drains, 250 miles of maintained levees and 186 miles of river channel.

Irrigated alfalfa near Socorro, New Mexico SCS PHOTO 12-P991-14

Irrigation water for the district is diverted from the river at four main points. In the district there are 121,680 acres of water right land of which about 40,000 acres are classed as "6W" (unsuitable for sustained irrigation). The El Vado Dam and Reservoir located on the Rio Chama about 17 miles west of Tierra Amarilla with a capacity of 194,500 acre-feet regulates the headwaters of the river for delivery and use in the district.

Principal crops grown in the district are in order of importance: alfalfa, cereal crops, fruit, and vegetables. Practically the entire crop production of the district is used locally.

Bluewater-Toltec Irrigation District - Application was made in November 1923 to appropriate water from Bluewater Creek for irrigation. Streamflows would be regulated in the proposed Bluewater Reservoir which would have 92,100 acre-feet of storage. Subsequently, in 1927, the application was amended reducing the storage capacity of the reservoir to 52,000 acre-feet. Proof of completion of the work was filed with the State Engineer Office in August 1927. In June 1948, the State Game and Fish Commission of New Mexico contracted with the District for a minimum pool of 3,500 acre-feet in the reservoir for fish culture and recreation. The district



Dam creates Bluewater Lake west of Grants, New Mexico. This is one of the subbasin's popular recreation areas. RBFP PHOTO

has water rights of about 16,500 acre-feet per year to irrigate about 5,500 acres of land in the Bluewater-Milan-Grants area. At present, a portion of the rights are being utilized by the uranium industry in the district.

Other Reservoir Projects - There are several small regulating reservoirs for irrigation serving private and Indian lands. One example is the San Mateo Dam and Reservoir located on San Mateo Creek about one mile east of the Village of San Mateo in North Central Valencia County. The dam was constructed in 1934 as a Federal Emergency Relief Administration project with a reservoir capacity of about 50 acre-feet. In 1954 needed repairs and an enlarged emergency spillway were completed by the state and the local water users.

Other Programs and Organizations

Bureau of Land Management (BLM)- Erosion control structures and stock tanks have been planned by the Bureau of Land Management for construction over a ten-year period. Since 1962, about one-half of these planned units have been completed. Thousands of acres of pinyon-juniper have been cleared and seeded to grass. Also several thousand acres of big sagebrush have been plowed and seeded to grass. An active program of proper range management is being carried out on lands administered by BLM.

Bureau of Indian Affairs (BIA) - A program to construct debris basins and erosion control structures exists under which the Bureau of Indian Affairs provides funds up to $2,500 per Indian land allotment for construction funds to match the USDA, Agricultural Conservation Program. A program of clearing pinyon-juniper lands and seeding to grass is also being carried out on lands where this practice is applicable.

Bureau of Sports Fisheries and Wildlife - Bosque del Apache National Wildlife Refuge, located along the Rio Grande 20 miles south of Socorro, was established in 1939 for the protection of the greater sandhill crane and wintering geese flocks. The endangered Mexican duck is native to the area and rests on the refuge. It covers more than 57,000 acres, 13,000 acres of which is bottomland.

The refuge bird list records 270 species of birds. Muskrat, beaver, mule deer, coyotes, and bobcat are also frequently observed.

Legumes and domestic grasses are established on 600 acres and grain crops occupy 1,250 acres.

Canadian geese on Bosque del Apache Wildlife Refuge SCS PHOTO 12-P991-3

Soil and Water Conservation Districts are groups of landowners organized under state law to identify and combat problems involving soil and water. These districts, using the programs of the Soil Conservation Service and other federal and state agencies, are an effective force to fight water and soil waste. Districts in the El Rio en Medio area include: Salado, Sandoval, Sierra, Central Rio Grande, Cuba, Socorro, East Valencia, McKinley, Lava, and Jemez.

Community Ditch Systems are recognized political subdivisions of the state. All of the irrigation systems except the Middle Rio Grande Conservancy District, systems on Indian lands, and the Bluewater-Toltec Irrigation District are operated by community ditch systems or "acequias".

State Developments for Recreation, Fish and Wildlife - The State Department of Game and Fish owns about 21,635 acres of land within the subbasin. These lands, in seven different tracts ranging in size from 110 to 14,500 acres, are utilized for big game, waterfowl, and upland birds management and for fishing. In addition, the department leases some 1,300 acres of land and water for fishing and waterfowl management. State trust lands are also leased by the Department for big game hunting.

Blue or scaled quail - popular upland New Mexico game bird.

N.M. DEPT. OF GAME & FISH

There are two state parks, Bluewater Lake and Elephant Butte Lake, encompassing leases of 42,160 acres of land and 19,350 acres of water. These areas are developed for water-based recreation. Major municipalities also operate and maintain parks, swimming pools, and other public recreation facilities.

The Four Corners Economic Development Region - A Four Corners Economic Development Commission was established in 1966 under Title V of the Public Works and Economic Development Act of 1965. All counties of the subbasin are within the New Mexico portion of this region.

Councils of Governments - The portions of Bernalillo, Sandoval, Valencia, and Torrance Counties within the El Rio en Medio Subbasin are in State Planning and Development District No. 3. This Council of Governments, operating under Federal Authority of Bureau of the Budget Circular A-95, the State Regional Planning Act, and local articles of agreement, provides sponsors of projects or practices unified, comprehensive and balanced cooperation among local governments. Through Councils of Governments, local prerogative and local autonomy is maintained in areas which have traditionally been under local jurisdiction. Local identity assumes real meaning as it becomes an integral part of the metropolitan area plan.

Population and Employment Trends

Population and employment show healthy gains over past decades and growth rates exceed those in the state as a whole. This is because Albuquerque, the largest city in the state (250,000 population) is located in the subbasin. The growth rate expected is as indicated in tables 2 and 3.

During 1930, 17 percent of the state population lived in the subbasin. This proportion grew to 33 percent in 1960 and is expected to be about 37 percent in 1980. This typifies to some extent the national "rural to urban" migration trend and the rapid growth of large southwestern United States cities. Population projections are based on data developed by the Bureau of Business Research (BBR), University of New Mexico, and the U. S. Office Business Economics--Economic Research Service (OBERS).

Two projections of subbasin population are shown in tables 2 and 3. The OBERS projections are based on a continuation of New Mexico's shares of national population. The BBR projections are based on the expected employment opportunities in New Mexico.

Employment in agriculture has decreased substantially and is projected to continue decreasing. This loss is compensated for by large increases in construction, manufacturing and services, especially in Bernalillo County.

Table 2, Population, El Rio en Medio Subbasin, 1930-1980

Year	Population in 1,000's: Trend	Projections: OBERS	Projections: BBR	Percent increase: Trend	Percent increase: OBERS	Percent increase: BBR	Percent state increase
1930	71.2						
1940	101.0			42			25
1950	177.8			76			28
1960	311.5			75			39
1970		385.2	424.9		24	36	27 1/
1980		481.8	601.7		25	42	35 1/

1/ Based on BBR projections.

Table 3, Employment, El Rio en Medio Subbasin, 1940-1980

Year	Trend	Projections: OBERS	Projections: BBR	Percent increase: Trend	Percent increase: OBERS	Percent increase: BBR	Percent state Increase
1940	26.8						
1950	60.3			125			56
1960	108.1			79			42
1970		129.1	155.3		20	43	37 1/
1980		171.6	216.8		33	39	34 1/

1/ Based on BBR projections

Water Rights Administration[1/]

New Mexico law provides that the surface and underground waters of the state belong to the public and are subject to appropriation for beneficial use. Such use is the basis, the measure, and the limit to the right to use of water and priority in time gives the better right. The underlying principle is known as the appropriative doctrine of water rights. Where it applies, the mere physical presence of water upon, within, or adjacent to land does not confer upon the owner of the land, ownership of the water or a right to its use.

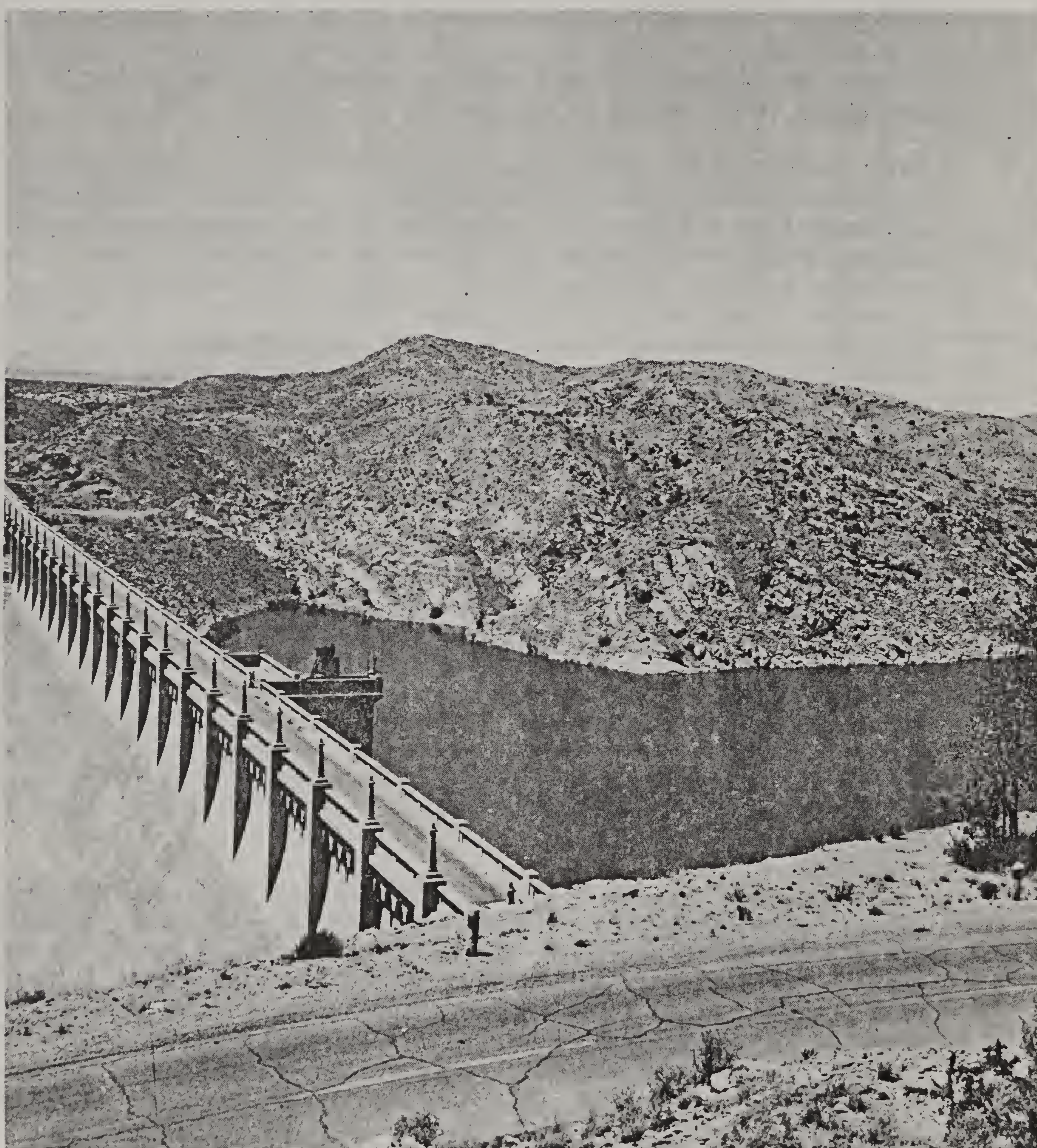
Water rights in New Mexico are administered by the State Engineer in accordance with provisions of the constitution and the statutes, the adjudication of the courts, the terms of interstate water compacts, and the rules and regulations of the State Engineer. Seven interstate compacts to which the state is signatory affect development and use of water in New Mexico. Situations in which there is intimate relationship between occurrence of groundwater and the flow of surface streams require coordinated administration of diversions by wells and by surface works in order to insure that valid water rights are served and that the state's ability to meet interstate water-delivery obligations is preserved.

Much of the El Rio en Medio area is within the boundaries of three declared underground water basins. They are Rio Grande, Sandia, and Bluewater. Waters of the subbasin are fully appropriated, consequently no new depletions of the available surface water supply is allowed. Permit to change the place and the purpose of existing water uses may be obtained providing the changes can be made without impairment of existing rights. To this extent, new water uses served by the existing supply are allowed. New uses may also be allowed if their effect on flows of the Rio Grande can be offset by imported water. Groundwater may be appropriated for new uses if the effects of such taking on the surface flow of streams are, at all times, offset by retirement of valid surface water uses.

The Rio Grande Compact, between the states of Colorado, New Mexico, and Texas, apportions waters of the Rio Grande stream system among these states and defines the obligations of the upstream states to deliver water by schedules that establish the outflow which must be maintained with a given inflow. New Mexico's obligation to deliver water to Elephant Butte Dam is established by the flow of the Rio Grande at the Otowi gage. The compact requires that appropriate adjustments be made to streamflows to reflect new or increased depletions in the applications of the schedules.

1/This statement was prepared by the Office of the New Mexico State Engineer

It defines and limits storage rights and protects the priority of the storage rights of Elephant Butte Reservoir over later upstream storages. The compact provides that the state, having the right to the use of any water imported to the Rio Grande Basin, shall be given proper credit therefor in the application of the schedules for delivery of water. Works to import water to the Upper Rio Chama are now being constructed.



SCS PHOTO 12-P992-10

Elephant Butte Dam - storage reservoir for lower Rio Grande irrigation

II. WATERSHED INVESTIGATION REPORT SUMMARIES

This section contains summaries of pertinent information from (1) ten watershed investigation reports, (2) the Corrales Watershed work plan which has been authorized for operations, and (3) the Sandias and (4) Belen-Los Lunas Watersheds which have been authorized for planning. The complete watershed investigation reports are contained in the appendix to this report along with data from the Corrales, Sandias, and Belen-Los Lunas Watersheds. These watersheds were selected for investigation because they have Public Law 566 potential for solving water and related land resource problems. The proposed projects appear to be physically and economically feasible, and should be initiated within the early action period. One of the projects is currently being planned.

A major problem in all of these watersheds is floodwater and sediment damage. The primary benefits would stem from reduction of flood damage. In addition to flood protection, these projects will reduce sediment damage downstream, reduce water pollution, improve the general environment, and may serve other justifiable purposes such as recreation and municipal and industrial water storage. The inclusion of water-using purposes must comply with laws governing the appropriation and use of the public waters of the state.

Benefits accruing to the general public include flood damage reduction to roads, bridges, streets, culverts, public utilities, and public recreation areas.

The proposed treatment on each watershed includes needed land treatment and structural measures.

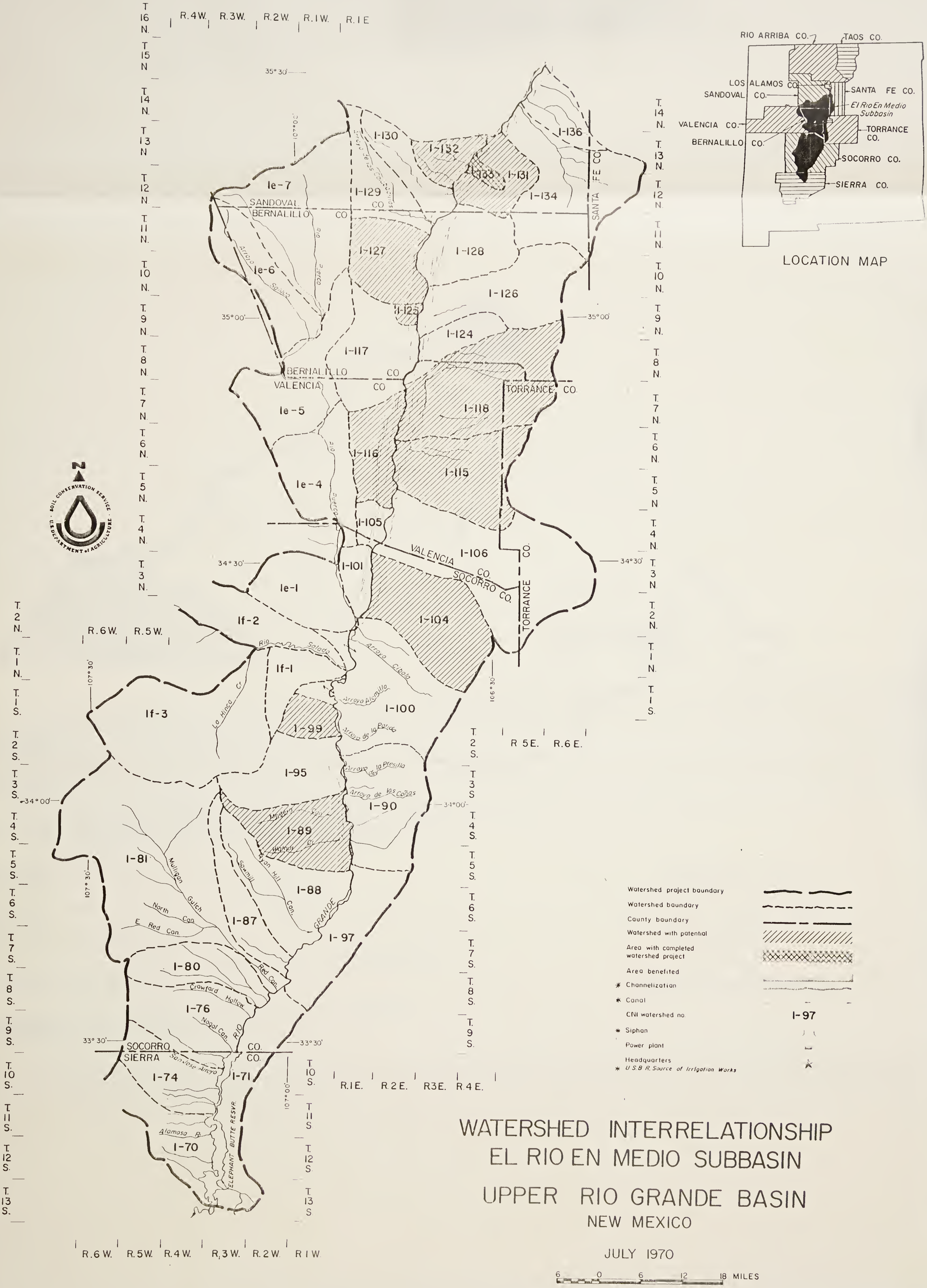
The potential flood protection projects within this subbasin and the El Rio Arriba Subbasin are all interrelated. All of the potential land treatment and structural measures are located on arroyos which are tributary to the Rio Grande.

Throughout the length of the Rio Grande there are many irrigation diversion dams. Any potential project which would decrease the amount of sediment delivered to the main stem of the Rio Grande would be of some benefit to each and every one of the diversion dams and the land on which the water is used.

The many diversion dams on the main stem of the river lead to many miles of irrigation canals for conveyance of irrigation water to the location of its use. Due to the topography and slope adjacent to the river channel, the conveyance systems intermingle, overlap, and cross one another all the way from the Cochiti Dam to the Elephant Butte Reservoir. The systems of intermingled canals convey water to irrigated lands which form an interrelationship of watersheds tributary to the Rio Grande.

Belen-Los Lunas Watershed Flood Results, June 1969 RBFP PHOTOS

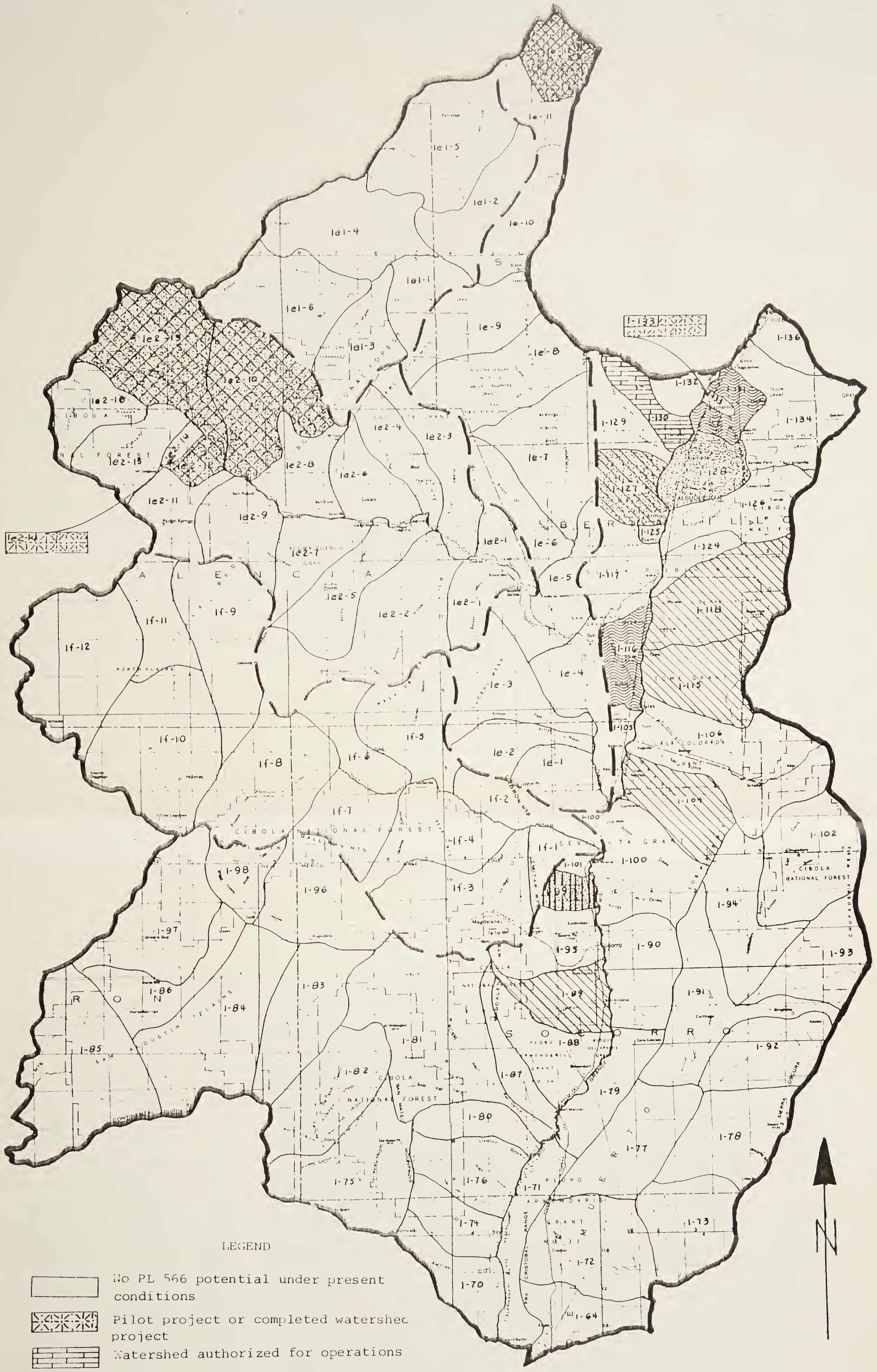
SOIL CONSERVATION SERVICE



WATERSHED INTERRELATIONSHIP
EL RIO EN MEDIO SUBBASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JULY 1970

M7-R-21742-N



LEGEND

No PL 566 potential under present conditions

Pilot project or completed watershed project

Watershed authorized for operations

Watershed with preliminary investigation, field examination, or river basin watershed investigation completed and having PL 566 potential

Watershed authorized for planning

Watershed work plan discontinued

Watershed application

Watershed with PL 566 potential (according to CNI data)

Watershed with application but not feasible at present time

WATERSHED MAP
RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY, 1970

10 0 10 20 Miles

Pajarito Arroyos Watershed

CNI #1-125

The watershed is located on the west side of the Rio Grande and includes portions of the city of Albuquerque. Numerous arroyos drain the slopes of the west mesa toward the Rio Grande. None of the arroyos have natural outlet channels to the river; therefore, they empty into the main irrigation canal filling it with floodwater, sediment, and debris causing flooding of the area below the canal.

There are about 7,300 acres subject to flood damage. This area is currently used for residential, small business, and interspersed farming. It is projected that within 25 years the damage area will be fully developed for residential use and will have a population of about 25,000.

The first increment for a watershed project should be land treatment programs consisting of measures that will encourage better vegetative cover conditions and result in reducing erosion and runoff from the rangeland. The cropland should be treated with measures that will improve irrigation water management and enhance productivity of the land. To supplement land treatment measures, five floodwater retarding structures with associated floodwater diversions and outlet channels are needed to obtain flood protection for the damage area. These structural measures would control about 89 percent of the drainage area and reduce present damages by approximately 92 percent. With a fully developed urban area and without flood control measures, the average annual damage is estimated to be $371,000. These damages could be reduced to about $30,000 annually with the installation of project measures resulting in a reduction of damages of $341,000. Redevelopment and secondary benefits associated with the installation, operation, and maintenance of project measures would be about $78,300 on an annual basis. Total project benefits are estimated to be $419,300, and when compared to the average annual cost of $266,500 for structural measures, a benefit-cost ratio of 1.6 to 1 is derived.

Hell's Canyon Watershed

CNI # 1-118

This watershed includes 183,872 acres of land located about 10 miles south of Albuquerque and takes in parts of Bernalillo and Valencia Counties, New Mexico. The relief pattern is to the west draining the west slopes of the Manzano Mountains. Arroyos in the watershed originally had channels which outletted into the Rio Grande. As the bottomland was developed, the arroyos were leveled. They now terminate and empty into the main irrigation canal. Channels to convey flood flows to the river are non-existent. Floodwater and sediment cause damages to roads, residences, irrigation facilities, farm equipment, and irrigated cropland. About 700 acres of crops and cropland are damaged every year from floods. Damages from

interrupted irrigation services occur on an additional 4,000 acres of land.

There is a need for improved land treatment and other flood prevention measures to control the floodwater and sediment discharged from the arroyos. Land treatment practices should consist of measures which will increase the vegetative cover, decrease erosion from all sources, retard runoff and improve agricultural water management. In order to obtain the level of protection needed, five floodwater retarding structures and outlet channels will need to be installed.

The agricultural area subject to flooding by the one-percent chance storm event is estimated to be 9,400 acres. There are approximately 400 farm homes, small businesses, and rural non-farm residences subject to flooding. Agricultural damages to crops and pastures amount to about $139,400 annually. Other agricultural damages requiring repairs to irrigation canals, farm roads and bridges, and releveling of cropland are estimated to be $24,200 annually. Average annual damages to urban developments are estimated to be $146,000. Indirect damages associated with flooding are estimated to be $31,000 annually. The sum of all of these damages amounts to $340,600 per year. After the project measures are installed, these damages will be reduced to about $17,000 annually, a reduction of 95 percent.

This will result in a damage reduction benefit of $323,600 annually. Redevelopment and secondary benefits associated with the installation and maintenance of project measures are estimated to be $96,450 annually. The sum of all project benefits evaluated amounts to $420,000, and the average annual cost of structural measures including operation and maintenance amounts to $325,700. A comparison of benefits and costs indicates that a benefit-cost ratio of 1.3 to 1 may be achieved.

Canyon Sales Watershed
CNI #1-115

The location of this watershed is in the east central part of Valencia County, New Mexico and about 25 to 30 miles south of Albuquerque. The watershed includes an area of about 147,100 acres. The drainage pattern is generally to the west. The arroyos originally had outlets to the Rio Grande, but in recent years the bottomland along the Rio Grande has developed into intensively used irrigated cropland. In the development of this land, the arroyos were leveled and are now being farmed. These arroyos have no channels into the river but drain into the main irrigation canal. They overflow the canal and flood the irrigated farmland below.

About every three years approximately 1,000 acres of land are damaged to the extent that crops are lost and the land must be re-leveled. In addition to the flood damage area, there are about 1,000 acres of irrigated cropland which suffers damage because canals are filled with sediment and water cannot be delivered to the fields. Several homes in the watershed receive flood damage almost every year. Highways, bridges, and farm roads are damaged annually.

Land treatment systems outlined in the watershed investigation report will encourage better cover and result in reduced erosion and runoff from the rangeland. To achieve the desired level of flood protection, land treatment practices will be supplemented by three floodwater retarding structures and related channel improvements. The average annual cost of installing these measures, including operation and maintenance is about $87,450. Without the flood protection, agricultural damages are estimated to be $46,000 and urban damages 54,800 annually. Indirect damage associated with the flood hazard is expected to be about $10,000 annually. After the installation of project measures these damages are expected to be reduced by about 90 percent. This reduction would yield about $99,700 in average annual benefits. In addition to these benefits, redevelopment and secondary benefits are estimated to be $27,000 annually. Total project benefits are estimated to be $126,700 annually. A benefit-cost ratio of 1.4 to 1 is derived by comparing total project benefits to the average annual cost of structural measures.

Pino Draw Watershed
CNI #1-104

The watershed is located in the northeastern part of Socorro County, about 27 miles north of Socorro. The arroyos in this watershed have no outlets to the river and empty into and overflow the canals and flood the irrigated farmland below. Flood damages are reported every year by the local people. On the average of once every three years about 1,000 acres of land are damaged to the extent that crops are lost and the irrigated land has to be releveled.

Floodwaters heavy laden with sediment flow into the canals filling them with sediment causing extensive damage due to curtailed delivery of irrigation water on about 5,600 acres of cropland. This includes some irrigated land outside of the watershed. Several homes are damaged in the communities of Las Nutrias and Veguita by floodwater almost every year. Highways and bridges are damaged annually. Three or four miles of State Highway 47 must be cleared of sediment each time the arroyos flood.

The watershed needs a land treatment program and flood prevention measures designed to reduce the floodwater and sediment damage to residences, businesses, highways, canals, and cropland. The land treatment program should consist of measures that will encourage better vegetative cover conditions and result in reducing runoff and erosion on the rangeland.

To provide the level of flood protection that is desirable for the area being damaged, five floodwater retarding structures with related outlet channels are recommended.

Average annual flood damages evaluated under present conditions amount to $170,800. After project measures are installed, the average annual damages will be reduced to $10,600. This is approximately 94 percent reduction in damages. Redevelopment and secondary type benefits accruing to local labor and associated business activities amount to about $44,100

annually. Average annual project benefits evaluated amount to about $204,300 and the average annual cost for structural measures is estimated to be $137,200. When average annual benefits are compared to average annual costs, a benefit-cost ratio of 1.5 to 1 is derived.

L e m i t a r - P o l v a d e r a A r r o y o s W a t e r s h e d
CNI #1-99

This watershed is about 4 miles north of Socorro on the west side of the Rio Grande and contains about 32,200 acres. About 3,000 acres of agricultural and urban land are subject to flooding. There are about 70 to 80 homes and small businesses located in this area and the area subject to flood damage contains 25 farms and a population of about 150 people. Cotton, alfalfa, small grains and corn are produced. There is also some vegetable production and garden tracts. The irrigated farmlands of the watershed are damaged nearly every year by flood flows from one or more of the arroyos. All of the arroyos terminate against the Lemitar-Polvadera canals. Sediment damage to the canal causes high maintenance cost.

Land treatment practices on cropland should include land leveling, ditch lining, and a proper combination of cropping conservation systems such as pasture and hayland management, timely tillage, and irrigation management. In addition to proper grazing use, the range land area should have limited livestock use, small gully control, water-spreading devices, surface roughening, critical area seeding, and brush control. These measures will encourage better vegetative cover conditions that will, in turn, reduce runoff and erosion.

A plan for flood control consists of four potential floodwater retarding structures with associated channel improvements.

The estimated average annual sediment and floodwater damage to crops and pasture, other agricultural facilities, and roads and bridges amounts to about $50,100. Average annual urban damages are estimated to be $44,800. Agricultural and urban damages, including indirect, combined, make a total of $103,200. After project measures are installed, these damages will be reduced to $17,700, or a damage reduction of about 81 percent, or average annual damage reduction benefits of $85,500. The value of local secondary benefits accruing to the project amount to $14,500 annually. Redevelopment benefits associated with watershed project measures are estimated to be $21,300 annually. Average annual benefits are estimated to be $121,300, and average annual costs estimated to be $102,300. The benefit-cost ratio is 1.2 to 1.

Walnut Creek Watershed

CNI #1-89

The location of this watershed is in the central part of Socorro County just south of the city of Socorro and includes about 78,500 acres. Floodwater and sediment cause damages to roads, bridges, residences, irrigation facilities, farm equipment and irrigated cropland. Floodwaters from the arroyos outlet directly into the main irrigation canal. Canals fill with sediment, inundating the irrigated cropland below the canal. About 700 acres of crops and cropland are damaged every year from floods. Damages from interrupted irrigation service occur on an additional 2900 acres of land. County roads are damaged annually from flood flows. At every arroyo crossing, the roads are washed out or covered with sediment. Homes and businesses are frequently damaged in the communities of Luis Lopez and San Antonio.

Land treatment needs consist of measures which will increase the vegetative cover, decrease erosion and sediment production from all sources, and retard runoff. Land treatment on the irrigated cropland is needed to improve water management and lower water tables in some locations. Twelve floodwater retarding structures are needed to supplement the land treatment program to provide the degree of protection needed. There are no existing channels to the river and outlet channels to the river will have to be installed to control the principal spillway discharge.

Damaging floods occur in most parts of the watershed on an average of once every year. The agricultural area flooded by the 100-year frequency storm is estimated to be 3,660 acres. This area is used mainly for the production of alfalfa, corn, irrigated pasture, and a small acreage of vegetables. Agricultural damages under present conditions are estimated to total about $187,200 annually. The installation of structural measures would reduce these damages to approximately $8,000 per year. This is a 95 percent reduction in damages and produces damage reduction benefits in the amount of $179,200 per year. Flood damages to farm and ranch homes and urban development amount to about $28,300 per year. These damages would be practically eliminated after the project is installed. Indirect damages associated with flood conditions amount to $21,500 per year. The installation of the project would result in a 96 percent reduction in these damages and would produce about $20,760 in average annual benefits. The average annual cost of all structural measures, including operation and maintenance, is estimated to be $217,800, and total average annual benefits are expected to be $295,800. A benefit-cost ratio of 1.4 to 1 is derived by comparing annual benefits with annual costs.

Nacimiento-Rito Leche Creek Watershed

CNI #le-12

This watershed is located in Sandoval and Rio Arriba Counties, in the vicinity of Cuba, 80 miles northwest of Albuquerque. The watershed has a drainage area of about 18 square miles. Floodwater and sediment damages are caused by overbank flooding of Nacimiento and Rito Leche Creeks. Both channels are so small that they overflow on an average of every two years. Both creeks have a small perennial flow and the local people are interested in water storage for recreational development. Residential and business districts of Cuba are the major areas of damage. The population of Cuba is about 1,000. There are about 350 acres of irrigated cropland in the damage area. This cropland is owned by about 50 operators and is devoted mostly to the production of alfalfa, small grains, grassland, and gardens.

More intensive application of land treatment measures and better control of grazing are needed. To supplement land treatment measures, two floodwater retarding structures and two floodwater diversions are recommended to achieve the desired level of flood protection. It is estimated that the agricultural area flooded by the 100-year frequency storm is about 150 acres. Agricultural flood damages are estimated to be $1,695 annually and will be reduced by about 90 percent with the installation of project measures. The reduction will provide benefits in the amount of $1,525 per year. The most significant flood hazard is the potential for damages in the urban area of Cuba. After increased urban development and housing development, the future urban damage is estimated to be $54,805. With the installation of structural measures for flood prevention, this damage could be completely controlled resulting in $54,805 in annual benefits. The average annual indirect damages associated with flooding would be about $5,650. These damages could be reduced to about $50 annually, yielding additional benefits of $5,600. The sum of the above damage reduction benefits is $61,930. Other project benefits from redevelopment and secondary sources amount to $17,100, and when added to damage reduction benefits of $61,930 provide a total of $79,100. When these benefits are compared to the annual equivalent cost of $55,900 for structural measures, a benefit-cost ratio of 1.4 to 1 is derived.

Pole-Zuni Watershed

CNI #le2-12

This watershed is a tributary to the Rio San Jose which passes through Milan and Grants. The drainage area is about 67,000 acres in size. Much of the residence and business development in Grants and Milan is in the flood plain. The watershed contains about 2,900 acres of previously irrigated cropland now idle because of flood damage and a shortage of irrigation water.

The needs for flood protection in the watershed may be met partially by a land treatment program emphasizing good range management, agricultural water management supplemented by three floodwater retarding structures and related diversions. Structural measures in the two adjoining watersheds of Rio San Jose and San Mateo-Grants will benefit this watershed.

The proposed structural sites are not particularly suited for recreation pools because they lack a constant source of water and the evaporation rates are high. The estimated average annual floodwater damage to crops, hay, and other agricultural and public utilities amounts to $7,800. Urban damages in the watershed amount to about $26,100 per year. Agricultural and urban damages combined make a total of $33,900. After project measures are installed, these damages will be reduced to $4,500 or a damage reduction of about 87 percent. The estimated value of local secondary and redevelopment benefits amount to approximately $7,660 annually. Total project benefits are estimated to be about $37,000 annually, and, when compared to the average annual cost of $23,900 for structural measures, a benefit-cost ratio of 1.6 to 1 is derived.

Rio San Jose Watershed

CNI #1e2-13

This watershed is located generally north of the village of Bluewater in the northern edge of Valencia County and the south central part of McKinley County. It includes a drainage area of about 224,600 acres. There are about 1,500 acres of irrigated farmland in the watershed much of which is subject to floodwater and sediment damage. The Atchison, Topeka, and Santa Fe Railroad passes through the watershed, part of which is in the flood hazard area. The Rio San Jose drainage contributes floodwater to the urban areas of Grants and Milan. Some damage is also sustained by installations of the uranium refining plants located in the area.

The land treatment program should consist of measures designed to increase vegetative cover and decrease erosion and runoff on the rangelands and improve agricultural water management on the cropland.

Structural measures recommended for flood protection consist of two structures with related channel improvements. With the two retarding structures in place,about 92 percent of the drainage area will be controlled.

Agricultural and urban damages evaluated in the watershed investigation report make a total of $141,800 annually. After project measures are installed, these damages would be reduced by about 89 percent producing benefits in the amount of $122,700. The value of local secondary and redevelopment benefits combined make a total of $30,100 annually. The average annual cost of structural measures is calculated to be $81,350, and average annual benefits $152,800. The benefit-cost ratio is 1.9 to 1.

San Mateo-Grants Canyon Watershed

CNI #1e2-10

This watershed is located in McKinley and Valencia Counties of northwestern New Mexico and contains about 213,700 acres. The town of Grants is in the southern tip of the watershed. Important developments are the Homestake Uranium Plant, the Atchison, Topeka, and Santa Fe Railroad, the city of Grants and part of the village of Milan. The watershed is within the Four-Corners Economic Development Area of New Mexico.

The San Mateo-Grants Canyon, San Jose, and Pole-Zuni Creeks watersheds form a combination of watersheds which contribute flood flows to a common floodplain. These three watersheds should be planned simultaneously to effectively utilize watershed planning resources and arrive at the most economic combinations of structural measures. The three watersheds individually and combined have resulted in flooding and sediment deposition in Grants, Milan, and on irrigated cropland. There are approximately 200 homes and other major fixed improvements subject to flooding. In August and September 1967, heavy rains in the area caused extensive damage in Grants to streets, bridges, homes and businesses. On four occasions the sewage disposal plant was completely inundated by water.

Flood control and sediment reduction measures in the San Mateo-Grants Canyon Watershed include a land treatment program designed to improve vegetative cover conditions which will reduce runoff and erosion. Structural measures recommended for flood control consist of four floodwater retarding structures and a major bypass channel around Grants. These structural measures have an average annual cost of about $95,200 and will provide project benefits in the amount of approximately $111,600. The benefit-cost ratio is estimated to be 1.2 to 1.

The following three watershed reports are on watersheds which have progressed beyond the watershed investigation stage and will be considered apart from the other watersheds.

Sandias and Belen-Los Lunas Watersheds have both been authorized for planning and the Corrales Watershed has been authorized for operations under the Public Law 566 watershed act.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

WATERSHED INTERRELATIONSHIP
GRANTS SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
OCTOBER 1970

M7-N-21822

Sandias Watershed
CNI #1-131

This watershed is located on the east side of the Rio Grande. The south boundary is about 5 miles north of Albuquerque and the north boundary is just south of Tonque Arroyo. Numerous arroyos and several canyons flow from the slopes of the Sandia Mountains to the Rio Grande. Since development of the valley area, only one drainage has a channel directly into the Rio Grande.

Land treatment systems include measures designed to improve vegetative cover conditions to achieve maximum stability in erosion and runoff from the upper portion of the watershed. It has been determined that 15 floodwater retarding structures, one floodwater diversion, and associated outlet channels and improvements will afford a desired level of protection. The dams and reservoirs are planned as single purpose flood control structures; however, permanent storage could be provided in some structures for recreation, municipal, and industrial use subject to New Mexico water rights regulations. The proposed structural measures and the completed structures on the Bernalillo pilot project will control about 66 percent of the watershed. It is estimated that flood damages will be reduced about 90 percent.

Floodwater and sediment damages in this watershed occur to crops, pasture, urban developments, irrigation facilities, and roads and bridges. The average annual damages without the project are estimated to be $255,500. With the project measures installed, these damages could be reduced to $28,500. The resulting damage reduction benefits would be $227,000. Other project benefits result from redevelopment and secondary sources. Redevelopment benefits are estimated to be $61,700 and secondary benefits $31,900. Total project benefits are estimated to be $320,600 and total annual costs of structural measures are expected to be about $295,600. These benefits and costs will provide a benefit-cost ratio of 1.1 to 1.

Corrales Watershed
CNI #1-130

The Corrales Watershed is located west of the Rio Grande in Sandoval and Bernalillo Counties, New Mexico, and covers an area of 85.5 square miles, or 54,720 acres. The community of Corrales is in the downstream portion of the watershed and is located about 10 miles north of Albuquerque. The watershed work plan has been completed and authority for installation of project has been given. The local sponsoring organization has obtained most of the land easements and rights-of-way needed for the installation of structural measures.

The information on this watershed is included here to indicate the relative importance it will have on the total development of the basin. In 1941,

approximately 400 acres of irrigated land were flooded including some homes, small businesses, the Corrales Main Canal and State Road 46. The 400 acres flooded are used mainly for alfalfa, orchards, vineyards, corn, and vegetables.

The estimated average floodwater damage in the watershed under future conditions without the project is $55,000. Average annual damage from sediment is estimated to be $12,290 under future conditions without the project. The watershed work plan indicates that one floodwater retarding structure and two floodwater diversions would be needed to provide the desired level of protection at the least cost. These structural measures will reduce the evaluated flood damage by approximately 98 percent. The average annual cost of structural measures is $128,880 and average annual benefits will be $202,100 and will provide a benefit-cost ratio of 1.6 to 1.

Belen-Los Lunas Watershed
CNI #1-116

The Belen-Los Lunas Watershed is located in Belen and Valencia Counties, and covers an area of about 69,670 acres. Approximately 21,000 acres of irrigated cropland is in the watershed. The remainder is in rangeland and miscellaneous lands. This watershed has been authorized for planning and work plan development is underway. The summary of this watershed investigation report is included here to indicate the need and relative impact it will have on the total basin resources use and development. Major problems are floodwater and sediment damages to irrigation canals, irrigated cropland and business and urban developments. A severe storm and damaging flood in Belen in June 1969 emphasized need for the project. The local people are most anxious to get the project planned and installed. It is recommended that the project consist of a comprehensive land treatment program on the upper watershed areas designed to improve vegetative cover and reduce runoff and erosion. This will be supplemented by four long dams to control all of the small arroyos contributing to floodwater and sediment damages. Inasmuch as the watershed is authorized for planning under Public Law 566 and planning for flood control works is in progress, cost estimates and structure data have not been made and will not be a part of this summary; however, it is the opinion of planning technicians that the watershed project will be physically and economically justified.

The estimated cost of applying needed land treatment to watershed lands is about $631,000. This cost converted to an annual equivalent and the annual cost of operation and maintenance amounts to approximately $82,400. Average annual returns on land treatment are estimated to be $200,000.

III. OTHER EARLY ACTION NEEDS

National Forest Development Program and Project Work Inventory

The development program includes the resource management and development work needed on the National Forests to assure that these public lands will contribute their full share of present and future public needs.

The program focuses on renewable resources of the National Forest System: water, timber, forage, recreation, and wildlife habitat. It provides for the continued orderly use and development of these renewable resources in accordance with the basic conservation principles under the Multiple Use-Sustained Yield Act of June 12, 1960. The program will be carried out as rapidly as possible within the overall budgetary requirements and financial resources of the federal government.

The Project Work Inventory (PWI) for 1967 lists non-recurrent work which should be initiated on the National Forests to meet estimated public needs. The basis for determination of these needs was (1) approved management and development plans and (2) the knowledge, vision and judgment of resource managers in the field.

Needs in the El Rio en Medio Subbasin as indicated by the PWI include revegetation of 203,000 acres, sheet erosion control on 25,300 acres, control of 2,500 miles of gullies to prevent erosion, stabilize 1,070 miles of abandoned roads and trails, stabilize 30 miles of streambank for erosion control, and provide 435 acres of sediment basins.

To manage the range resource more effectively, about 890 miles of fence and 585 domestic stock and wildlife watering facilities are needed.

The timber resource can benefit by treatment of 52,000 acres, and fuel treatment is needed on 22,000 acres.

Recreational development of 1,700 acres and improvement of 18 miles of stream for fish habitat is estimated to be needed.

Proper and efficient administration of all resources is dependent to a great extent on an adequate transportation system. Such a system will require construction and betterment of about 1,600 miles of roads and trails.

The cost of these programs is estimated to be in excess of 50 million dollars.

Holy Ghost picnic area, Jemez Pueblo enterprise FS PHOTO

Typical picnic "set", U. S. Forest Service FS PHOTO

RECREATION AND TRANSPORTION MAP
RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

a1

Recreation

Recreation use is expected to about double by 1980. Additional recreational facilities will be required to accommodate this increase. An estimated total of 5,000 acres of land will be required to satisfy the demand for developed area use.

In 1968, an estimated 4,500 acres of land, 17,000 surface acres of water, 290 miles of stream, and 70 miles of trail were available for recreational use. The big game population in El Rio en Medio Subbasin is estimated to be 300 elk, 45,000 deer, 700 antelope, 100 bear, and 1,500 turkeys.

Existing and planned recreational developments will be adequate to satisfy the estimated needs of the subbasin for 1980. Table 4 is a listing of the recreation use in the subbasin in 1968 and expected use in 1980. Table 5 is a listing of use and needs for developing recreational areas, expressed in acres. No attempt was made to project needs for dispersed area uses. Generally all areas are available for dispersed activities and uses can only be more intensified.

Land Treatment

Good management, vegetative manipulation, and mechanical land treatment are methods by which the land can be induced to contribute more to the subbasin economy. Land treatment can be planned so the El Rio en Medio study area will produce more forage, timber, water, and food. The same land treatment can reduce the amount of damaging sediment and provide for wide-scale employment of local people. Table 6 estimates land treatment impacts from land subject to United States Department of Agriculture programs. The land treatment map portrays the land treatment and vegetation areas in the subbasin.

Approximately one and three-fourth million acres are critically eroded and special methods are needed to reduce erosion and restore the area to productive use. These areas of critical erosion need a system of land treatment that includes the proper combination of the following practices: livestock exclusion or limited livestock use, gully control, water spreading or erosion control devices, grazing land mechanical treatment, fencing, relocation of watering points, intensive vegetative management, and critical area seeding.

Of the 5 million acres of grassland, 2,913,000 acres need better range management to realize its economic potential. Treatment will include the proper combination of these practices: deferred grazing, rotation-deferred grazing, proper grazing use, and better livestock distribution with fences and water locations.

Table 4, Present and projected recreation use, El Rio en Medio Subbasin (visitor days 1,000's)

Activity	Existing use 1970			*Projected use 1980		
Developed sites	National Forest	Other	Total	National Forest	Other	Total
Observation	10.1	31.6	41.7	36.3	46.3	83.1
Playgrounds, sports	-	-	-	-	-	-
Swimming	-	5.1	5.1	-	7.5	7.5
Campgrounds	32.5	80.0	112.5	125.4	118.3	247.3
Picnic grounds	29.6	120.0	149.6	116.2	177.6	293.8
Hotel, Lodge, Restr.	-	6.3	6.3	-	9.3	9.3
Organizational	-	2.0	2.0	-	2.9	2.9
Comm. services	-	6.3	6.3	-	9.3	9.3
Rec. res. sites	5.3	-	5.3	20.4	-	20.4
Winter sports	-	-	-	6.4	-	6.4
Visitor centers	-	-	-	-	-	-
Subtotal	77.5	251.3	328.8	304.7	371.7	676.4
Dispersed areas						
Roads (rec.)	78.5	-	78.5	300.8	-	300.8
Trails (rec.)	7.1	63.2	70.3	27.5	93.4	120.9
Streams	.4	94.7	95.1	1.2	140.2	141.4
Lakes	4.0	315.7	319.7	14.4	467.2	481.6
General undeveloped	69.3	269.3	338.6	261.0	398.5	659.5
Subtotal	159.3	742.9	902.2	604.9	1099.3	1704.2
Grand total	236.8	994.2	1231.0	909.6	1471.0	2380.6

*NFRS-BOR projections

Table 5, Present and projected recreation use and land needs, developed areas

Activity	Present use 1970			Projected use 1980	
Developed sites	Visitor days (1,000s)	Land needs (acres)	Conversion factor	Visitor days (1,000s)	Land needs (acres)
Observations	41.7	33	.0008	83.1	66
Playgrounds, sports	-	-	-	-	-
Swimming	5.1	16	.0032	7.5	24
Campgrounds	112.5	1012	.0009	293.8	2644
Hotel, lodge, restr.	6.3	11	.0017	9.3	16
Organizational	2.0	5	.0025	2.9	7
Comm. service	6.3	11	.0017	9.3	16
Rec. res. sites	5.3	15	.0027	20.4	55
Visitor centers	-	-	-	-	-
Winter sports	-	-	.0035	6.4	22
Total	328.8	2448		676.4	5043

Ranchers clearing juniper-invaded rangelands SCS PHOTO

Table 6, Land treatment needs and impacts (1969-1980), El Rio en Medio Subbasin

Land treatment systems	Needs treatment (acres)	Total treatment cost $	Impacts - Average annual value: Water $	Sediment reduction $	Red Meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.	136	93,100	125,400	-	-	-	-	125,400	7
1c-Good range mgt.	2,913,000	1,456,500	-	195,400	1,656,000	-	-	1,851,400	138
2. Woodland									
2a-Pinyon-juniper control	627,000	10,659,000	-	11,500	564,300	-	-	575,800	800
2b-Pinyon-juniper mgt.	1,513,000	15,130,000	-	50,700	906,200	-	-	956,900	1,135
3. Brushland									
3a1-Sagebrush con.	3,000	36,000	-	300	6,700	-	-	7,000	3
3b1-Sagebrush mgt.	75,000	1,125,000	-	5,300	168,700	-	-	174,000	84
3a2-Chaparral con.	3,000	18,000	343,700	300	3,400	-	-	347,400	1
3b2-Chaparral mgt.	21,000	157,500	-	1,500	23,600	-	-	25,100	12
3a3-Creosote brush control	43,000	516,000	-	4,900	96,700	-	-	101,600	39
3b3-Creosote brush mgt.	103,000	1,236,000	-	7,200	231,700	-	-	238,900	93
3a4-Mesquite brush control	75,000	750,000	-	8,600	67,500	-	-	76,000	56
3a5-Rabbitbrush control	32,000	480,000	-	3,700	72,000	-	-	75,600	36
3b5-Rabbitbrush mgt.	33,000	495,000	-	2,300	73,800	-	-	76,100	37
4. Commercial timber									
4a-Spruce-fir mgt.	32,000	1,280,000	117,300	1,600	36,000	126,400	-	281,300	96
4b-Ponderosa pine mgt.	191,000	5,730,000	175,000	9,300	214,900	735,300	-	1,134,500	430
4c-Aspen mgt.	3,000	90,000	11,000	100	3,400	700	-	15,200	7
5. Bottomland									
5a-Phreatophyte control	27,000	810,000	891,000	-	243,000	-	-	1,134,000	61
5b-Bottomland mgt.	16,000	160,000	-	-	36,000	-	-	36,000	12
6. Cultivated									
6a-Irrigated									
6a1-Drainage	28,140	562,800	-	-	-	-	2,110,500	2,110,500	42
6a2-Imp. irrigation	59,760	6,573,600	-	-	-	-	4,482,000	4,482,000	493
6b-Dryland	110	2,200	-	-	-	-	400	400	-
6c-Abandoned cropland	11,000	165,000	-	100	99,000	-	-	99,100	12
7. Critical erosion area	1,785,000	26,775,000	-	755,700	-	-	-	755,700	2,008
Totals		74,300,700 1/	1,663,400	1,058,500	4,502,900	862,400	6,592,900	14,680,100	5,602

1/ Total treatment cost converted to annual equivalents is $6,600,000

LEGEND

1	GRASSLAND MANAGEMENT
2	PINYON-JUNIPER MANAGEMENT
3-1	SAGEBRUSH MANAGEMENT
3-2	CHAPARRAL MANAGEMENT
3-3	CREOSOTEBUSH MANAGEMENT
3-4	MESQUITE MANAGEMENT
3-5	SAND SAGEBRUSH MANAGEMENT
3-6	RABBITBRUSH
4a	SPRUCE - FIR MANAGEMENT
4b	PONDEROSA PINE MANAGEMENT
4c	ASPEN MANAGEMENT
5	BOTTOMLAND VEGETATION MANAGEMENT
6a	IRRIGATED CROPLAND MANAGEMENT
6b	DRY CROPLAND MANAGEMENT
6c	MANAGEMENT OF LAND PREVIOUSLY CULTIVATED - NOT WELL VEGETATED
8	CRITICAL EROSION AREA MANAGEMENT (These areas from the Gross Erosion Map and are > 1 acre-foot/sq mi/year sediment producers)

Scale
5 0 5 10 15 Miles

LAND TREATMENT MAP
RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY 1970

Brush control using machinery SCS PHOTO 12-P830-2

Brush control results SCS PHOTO 12-P830-6

Grass seeding results after clearing pinyon-juniper near Magdalena

About 11,000 acres of land which were formerly cropped have been abandoned and are producing about 15 percent of potential. These abandoned fields need to be reseeded and erosion control measures installed to give the areas a chance to recover and stabilize.

Of the more than two million acres of pinyon-juniper woodlands needing treatment, more than one-fourth have moderately deep soils and moderate slopes upon which a woodland control program can be developed. The other three-fourths of the area need good range management supplemented by selective thinning and spot clearing where adaptable.

About 18,000 acres of big sagebrush, 24,000 acres of chaparral, 146,000 acres of creosote bush, 75,000 acres of mesquite, 60,000 acres of sand sagebrush, and 65,000 acres of rabbitbrush need treatment. About 127,000 acres can be cleared and reseeded to grass and the rest managed by using intensive management techniques including deferred grazing, rotation deferred grazing and better livestock distribution through use of fences and water locations.

There are 226,000 acres of commercial timberland in the basin that need treatment. Depending on vegetation type, management practices include block and strip cutting, selective cutting, thinning, tree planting, fire protection, grass seeding, erosion control on trails and roads, proper grazing use, and wildlife habitat improvement.

About 43,000 acres of bottomland vegetation along the main stem of the Rio Grande and its principal tributaries need treatment. These are phreatophytes that have little beneficial use. Twenty-seven thousand acres need to be cleared and replanted to adapted grasses. About 16,000 acres should be managed for wildlife habitat, streambank protection, and recreation areas.

There are about 65,000 acres of irrigated land and 100 acres of dry cropland that need treatment. On irrigated land drainage is needed on 28,000 acres and 60,000 acres need improved irrigation systems that include land leveling, sprinkler systems, pipelines, ditch lining, and realigning field ditches.

SCS PHOTO 12-P287-3

Net wire diversion - erosion control on Rio Puerco Drainage

Agricultural Water Management

Irrigation along the Rio Grande and its tributaries has been practiced for more than 900 years. The Pueblo Indians who occupied the valley prior to the time of Spanish exploration used simple irrigation systems and methods. Development along the Rio Grande was well established in the early seventeen hundreds. It is reported that maximum irrigation development occurred in 1880 when 124,800 acres were developed. For the next 40 years the acreages irrigated declined. Initially all irrigation in the area was from surface water. In recent years, groundwater sources have also been developed for irrigation. Much of the irrigation considered in this report uses a combination of surface and groundwater.

Irrigation throughout the state of New Mexico accounts for about 90 percent of the annual depletion for beneficial uses of the state's surface and groundwater supplies. 1/

Mean annual runoff of contributing streamflow from the area considered in this report is relatively insignificant. Mean annual runoff of contributing streamflow varies from less than 0.1 inch over most of the area to about 2 inches in the Manzano Mountains and 5 inches on Mount Taylor. 2/

Irrigated farming acreage distribution is as follows:

Main stem of Rio Grande	80,860 acres
Tributaries	13,960 acres
Total	94,820 acres

Except for the Rio Grande Valley and near Bluewater, surface waters are diverted and delivered by private or community ditch systems. These small systems are inefficient in operation and the delivery of water.

In the Grants-Bluewater area, the surface water is controlled and delivered by the Bluewater-Toltec Irrigation District. Of the approximately 5,488 acres of water rights in the area, uranium companies are using about 60 percent of the water rights. Much of the area, including uranium interests, use supplemental groundwater. To be effective and efficient as an irrigation water delivery system, reorganization and rehabilitation of the ditches need to be accomplished. The surface water used in the irrigation district comes from Bluewater Creek which has the Bluewater reservoir as a storage facility. The groundwater supply is from the Bluewater Basin which is an underground water basin declared by the New Mexico State Engineer.

1/ Consumptive Irrigation Requirements of Selected Irrigated Areas in New Mexico - NM State U. Ag. Experiment Sta. Bulletin 531, Aug. 1968.

2/ Characteristics of the Water Supply in New Mexico. New Mexico State Engineer Tech. Report 31 (1965).

Poor water management SCS PHOTO 12-P615-16

Good water management SCS PHOTO 12-P615-14

During the early part of the 1900's unsuccessful attempts were made to secure a program to rehabilitate the irrigated areas along the Rio Grande. Continued deterioration of valley lands finally caused community action that resulted in the formation of the Middle Rio Grande Conservancy District in 1925. By 1936, the district had constructed works to serve 118,000 acres.

A comprehensive plan for the Middle Rio Grande Valley, approved by Congress in 1948, authorized the U. S. Bureau of Reclamation to do the following:

1. Irrigation and project rehabilitation of the Middle Rio Grande Conservancy District.

2. Rehabilitation of El Vado Dam and diversion dams.

3. Drainage rehabilitation and extension.

4. Rectification of the channel of the Rio Grande in the Middle Valley including the Espanola Valley, and the reach from Elephant Butte Dam to Caballo Reservoir.

At present the Conservancy District operates and maintains the following:

1. One storage dam and reservoir (El Vado)

2. Four diversion dams

3. Five drainage wells

4. 202 miles of unlined main canal

5. One-quarter mile of concrete-lined main canal

6. 578 miles of unlined laterals

7. 393 miles of open drains

8. 250 miles of maintained levees

9. 186 miles of maintained river channel

The outlet works at El Vado Dam were recently modified to permit the passage of San Juan-Chama Project waters through El Vado Reservoir as required to satisfy the Rio Grande compact schedules of water delivery and to insure non-impairement of existing water rights.

Many of the unlined laterals and on-farm laterals and head ditches could serve the water user better if they were concrete lined. To best accomplish the needed reorganization of ditches and laterals, a joint effort in planning and installation by the conservancy district, state and federal agencies would be advantageous.

Even though 393 miles of open drains are in use, many acres of choice farmland have a high water table. This problem is causing reduced crop production on these lands. To solve this problem a comprehensive program should be initiated to drain areas seriously affected by a high water table. The program should be carried out to meet the needs for drainage on individual farms and local problem areas. The program should be planned and executed by a joint effort of the local people and state and federal agencies.

<u>The Practice of Irrigation</u> - Irrigation efficiency is often defined as the percentage of water applied to the land expressed in harvested (or harvestable) crops. The improvement of irrigation efficiencies is the most critical need in the conservation of water supplies. The major problems of crop production are poor management of irrigation systems and poor farming practices. With the rising costs of production and the scarcity of water for irrigation in the Rio Grande Valley, these problems will assume greater importance in the future. Irrigation efficiencies can be increased by reducing the losses of water in conveyance runoff, deep percolation, and evaporation. Israelsen stated that:

> *"Because of the many sources of loss of irrigation water between the time and place of diversion and where it is stored in the root zone soil as water readily available to plants, the irrigation efficiency on most projects is low, probably less than 33 percent."* 1/

Sprinkler irrigation, lining of canals and/or laterals, and pipelines for water delivery would help improve farm irrigation efficiencies up to 70 percent for a well-managed system.

Commonly used estimates for farm irrigation efficiencies in New Mexico range from about 30 to 50 percent. Some speculations on the significance of irrigation efficiencies in the El Rio en Medio Subbasin are shown in the table.

This analysis indicates that, if the farm irrigation efficiency could be raised from 50 to 70 percent, 113,760 acre feet less water would be required to be delivered at the farm headgate. Further, if it were assumed that transportation losses amounted to 30 percent of the water diverted, then the diversion requirements for irrigation in the area would be decreased by 162,500 acre feet annually or an average of about 1.7 acre feet per acre. Not all of the 162,500 acre feet of water is lost to the basin, but may be recoverable by return flow to the streams or from wells. However, some of the water may be lost to the basin through consumptive use of riparian vegetation and evaporation from wetted soils, swamps, and open water areas. The amount of water consumed by these uses is not known, but if it were assumed that one-third of the 162,500 acre-feet would be depleted and that water had a value of $22.00 an acre-foot, the average

---

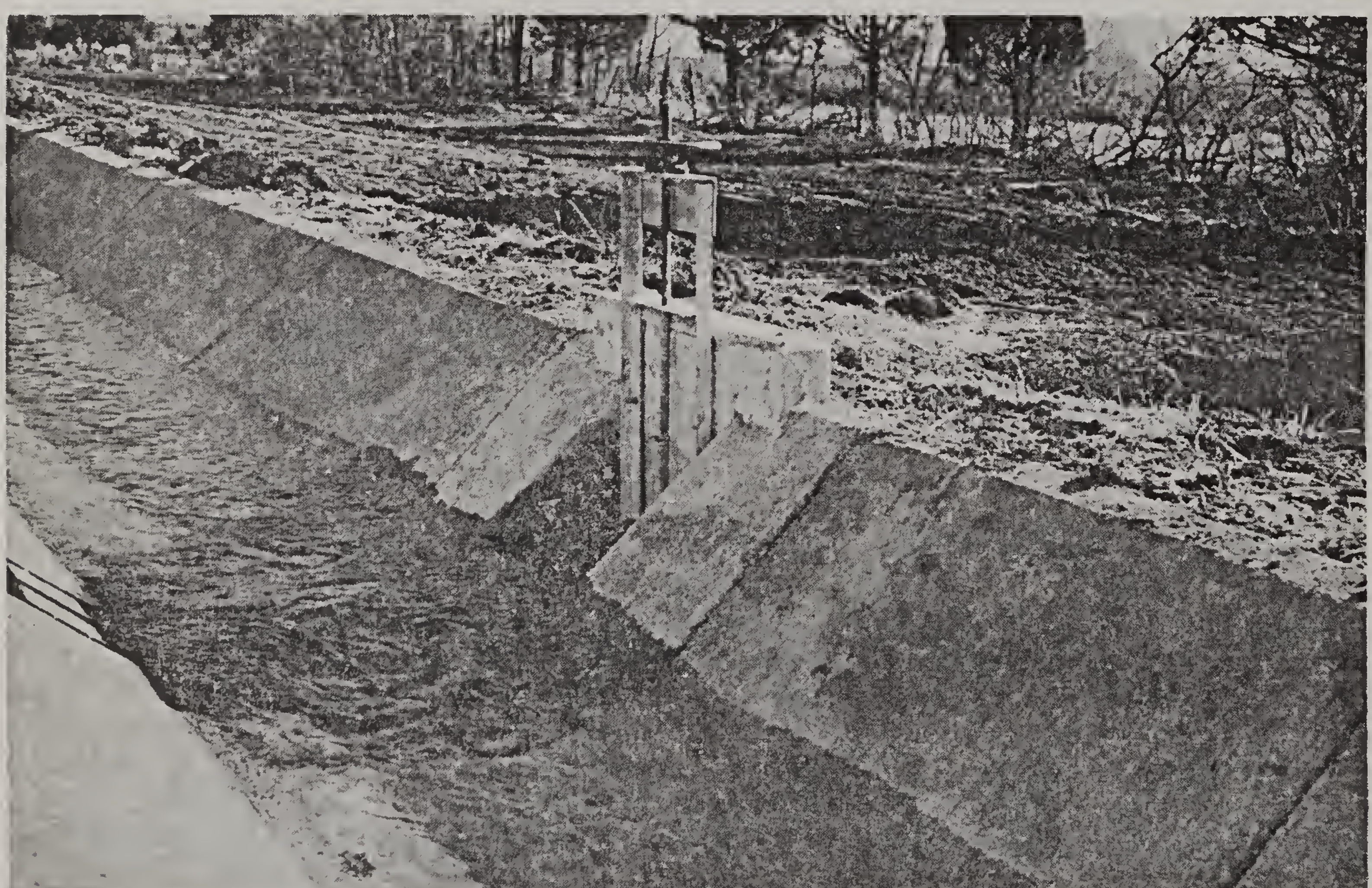
1/ Irrigation Principles and Practices, Orson W. Israelsen, PhD.

annual savings would be about $1,191,700; and, at $50/acre-foot, the average annual savings would be about $2,707,500. The following tabulation gives the total diversion requirement for various farm irrigation efficiencies and the value of water saved annually.

In addition to these losses, there are definite losses to the farmer and the community when irrigation efficiencies are low. These are:

(1) Fertilizers leached or washed away,
(2) Pollution of stream and underground water,
(3) Varying the water table and increasing necessary drainage,
(4) Loss of use of land due to high water table,
(5) Loss of topsoil due to erosion, and
(6) Cost of fighting mosquitoes.

In most areas of the subbasin soil conditions are such that subsurface drains can be installed and effectively lower the water table. Either open, closed, or a combination of open and closed drains can be effective. In some localized areas of channel aggradation, it may be necessary to pump drainage water into the river.



Concrete-lined irrigation canal saves water, moves it faster, reduces labor and decreases maintenance cost. SCS PHOTO 12-P614-10

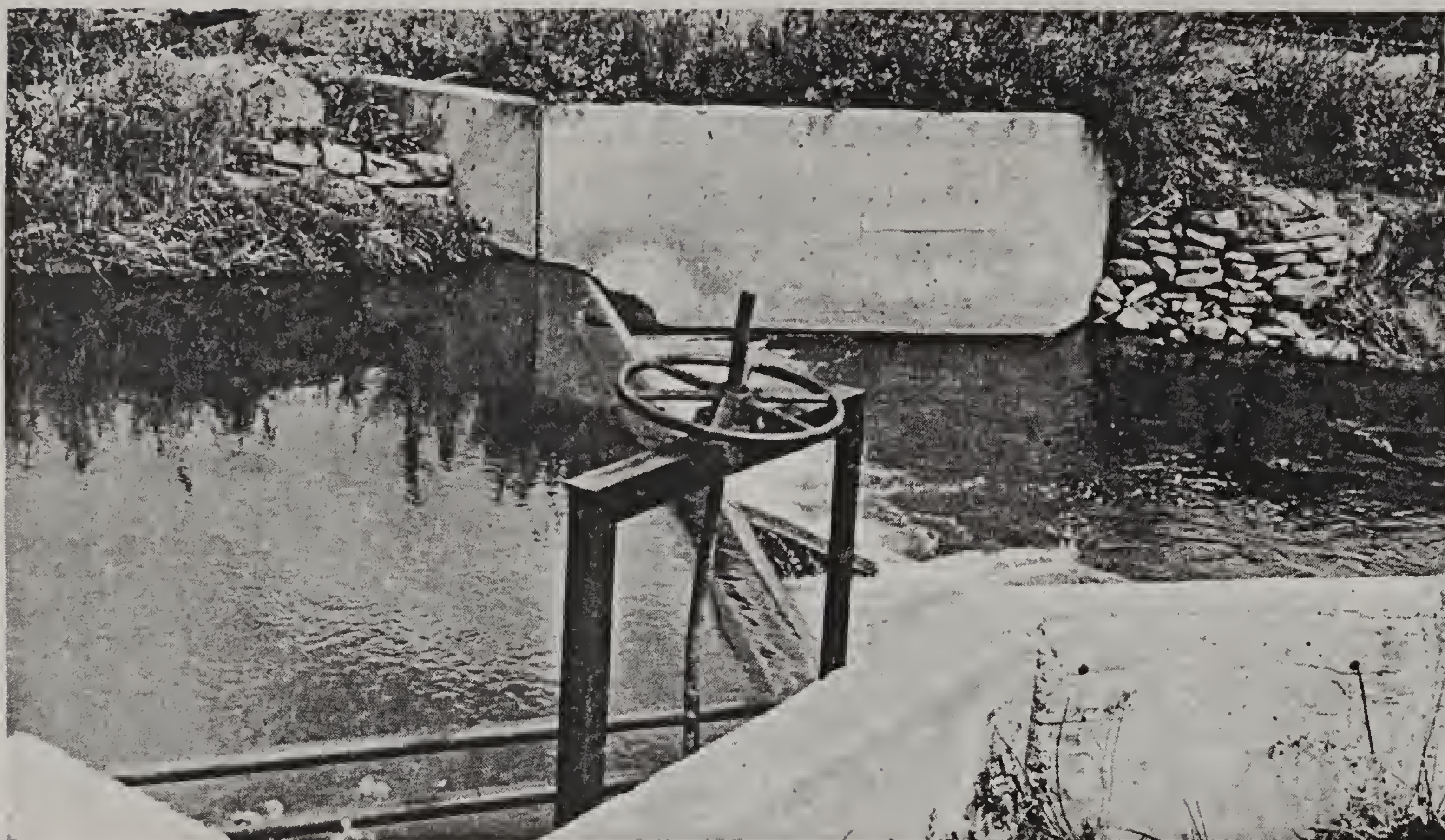
Table 7, Significance of irrigation efficiencies in the El Rio en Medio Subbasin (94,800 acres)

Farm irrigation efficiency	Total farm delivery requirement	Difference in diversion requirement	Average annual savings in $1,000			
			1/	2/	3/	4/
%	(acre-feet)	(acre-feet)				
30	658,000					
40	493,500	49,300	1,084,600	2,465,000	12,325,000	147,000,000
50	394,800	78,960	1,373,100	3,948,000	19,740,000	236,880,000
60	329,000	98,700	2,171,400	4,935,000	24,675,000	296,100,000
70	282,000	112,800	2,481,600	5,640,000	28,200,000	338,400,000
75	394,000	118,440	2,605,600	5,922,000	29,610,000	355,320,000

1/ Water valued at $22.00 per acre-foot (value if used for irrigation in Upper Rio Grande Basin)
2/ Water valued at $50.00 per acre-foot (estimated value of water in the Elephant Butte Reservoir)
3/ Water valued at $250.00 per acre-foot (recreation use)
4/ Water valued at $3,000 per acre-foot (municipal and industrial use)

Assumptions:

Irrigation acreage equals 94,800 acres
Acreage consumptive irrigation requirements equal 2.1 acre-feet per acre.



Irrigation pipeline used to increase irrigation efficiency SCS PHOTO 12-P560-15

Municipal and Rural Domestic Water 1/

Water Quality

There are thirty-nine communities in the El Rio en Medio area with populations in excess of one hundred people. The quality of water supplies in these communities is generally very hard. The ratings are as follows:

Very hard	28 communities out of 39
Hard	4 communities out of 39
Moderately hard	5 communities out of 39
Soft	2 communities out of 30

Specific mineralization of water which exceeds New Mexico State Health Department standards are noted as follows:

Water high in iron - Communities of Lemitar, Los Ranchos de Albuquerque, Magdalena, Paradise Hills, Skyview Acres, Thoreau, and Tijeras.

1/ The Nation's Water Resources Summary Report, United States Water Resources Council, 1968.

Municipal Water Supplies and Uses-Northwestern New Mexico, Tech. Report 29C, New Mexico State Engineer, Santa Fe, New Mexico

Water high in dissolved salts - Bluewater, Cubero, Encinal, Lemitar Mesita, Old Laguna, Paraje, Polvadera, and Seama.

Water high in nitrate - Communities of Polvadera and Vegueta.

Water high in sulfate - Communities of Bluewater, Encinal, Grants, Lemitar, Mesita, Old Laguna, Paraje, Polvadera, San Antonio, San Rafael, and Seama.

Water Quantity

Municipal and rural domestic water needs and consumptive use for the area are projected as follows:

Year	Communities with population of more than 100 (acre-feet/day)	Communities with population less than 100 & rural (acre-feet/day)	Total
	NEEDS		
1970	190.62	5.06	195.68
1980	330.30	6.10	336.40
	CONSUMPTIVE USE		
1970	103.30	3.54	106.84
1980	199.92	4.07	203.99

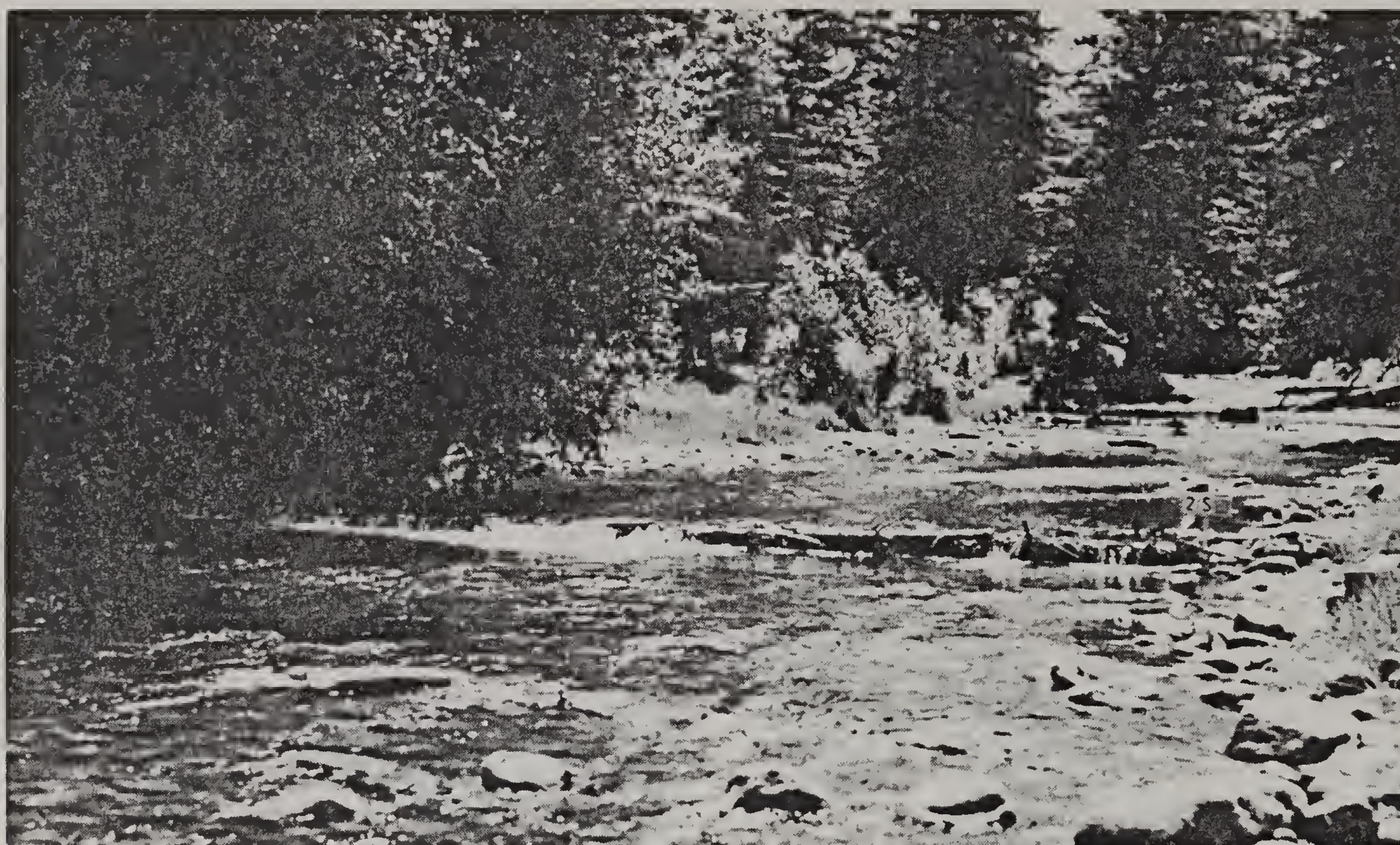
Water and Sewerage Development Needs

The population of the area is calculated and projected to be as follows:

Year	Municipal (communities with 100+)	Rural (and communities with less than 100)	Total
1965	336,300	30,500	366,800
1970	400,700	31,100	431,800
1980	566,400	33,100	599.500
1990	757,400	35,100	792,500
2000	996,300	37,900	1,034,200
2010	1,286,100	41,100	1,327,200
2020	1,627,800	45,300	1,673,100

The projections of population give an indication of the future demands for community water and sewage developments, and of the private water and sewerage needs in the rural sectors of the area.

In 1969, the water and sewerage needs of the thirty-nine communities were analyzed as follows:



Clear mountain stream FS PHOTO

Silt laden river RBFP PHOTO

Community water systems are needed for 14 of the 39 communities. Water systems are being planned for 8 of the communities. Community sewerage systems are needed in 21 of the 39 communities. Of the 21 needed, 10 are currently being considered or planned.

Projected increasing population and the corresponding increase in water needs, points out the nature and magnitude of the water and sewerage development needs. These are expressed in dollar costs as follows for the early action period.

1. For the "Early Action Period" (now until 1980), the objectives of local community leaders of providing a safe and healthy environment for the local people through community water and sewerage systems are summarized as follows:

    a. The population is predicted to grow from 366,800 to 599,500 people, an increase of 232,700 people. (By the year 2020, the population is predicted to grow to 1,673,100 people, an increase of 1,306,300).

    b. To bring all communities and the rural population up to an 80 percent "hook-up level" for residents, and to keep pace with the expanding poulation, there will need to be a total expenditure of $100,046,000.

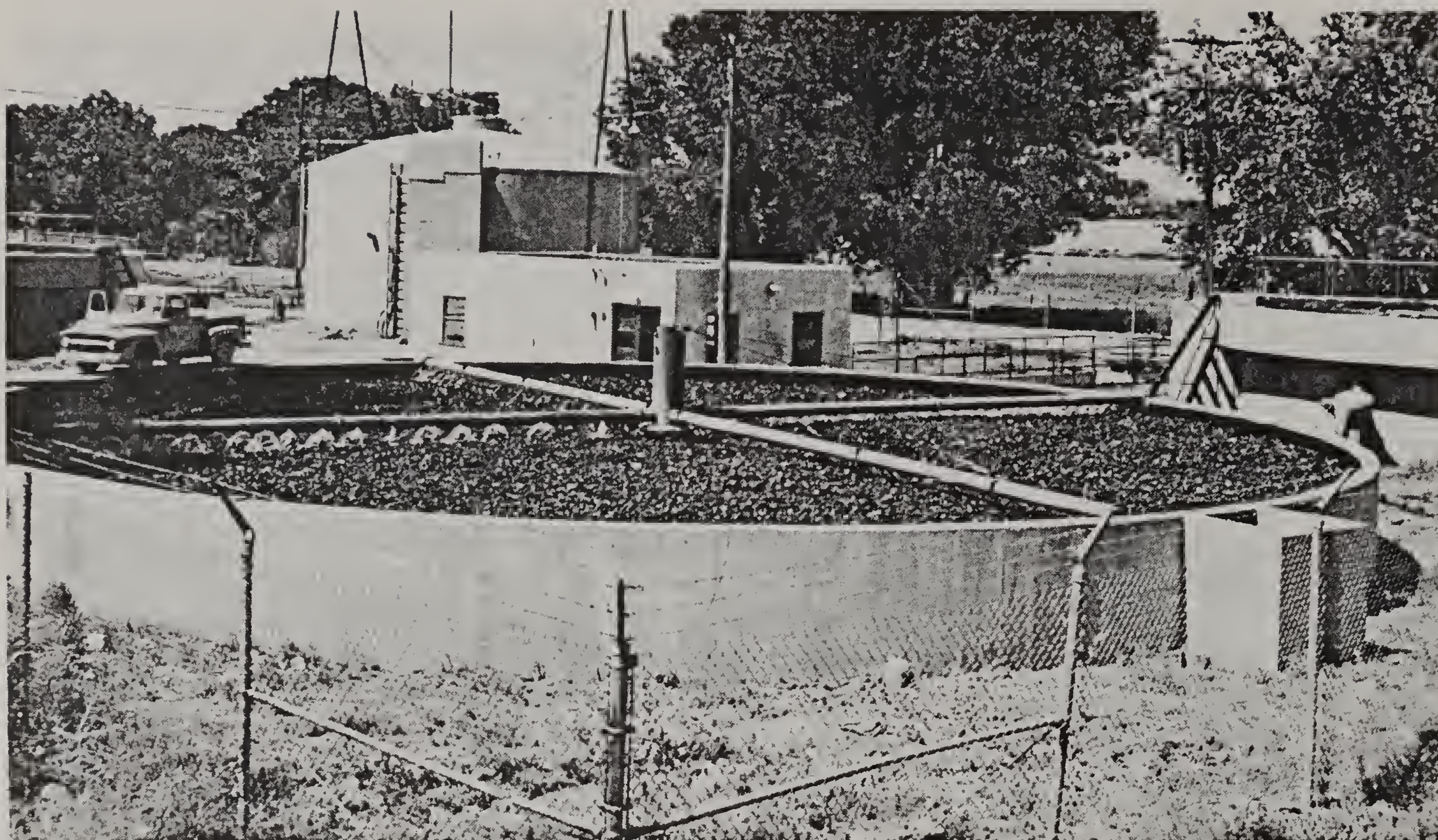
    c. Assistance is available to the local people of communities of more than 100 persons and less than 5,500 people from the Farmers Home Administration through Public Law 660. The potential for such assistance is approximately $3,195,000. This is on the basis of sharing 30 percent of the cost. In addition, the state of New Mexico offers cost-share assistance up to $12,000 per community. The potential for such assistance is $240,000.

    d. If the federal and state assistance is utilized to the maximum, the local people will still have a total expenditure of $96,611,000 as their share of the cost of water and sewerage development.

2. The water and sewerage development needs are: Total for 1970 is $40,323,000 and for 1980 the total is $59,723,000.

Under certain conditions, local sponsors can obtain loans and grants up to 50 percent of the development cost of a water or waste disposal system under USDA's Public Law 87-128 (amended by PL 89-210) and Public Laws 87-703 and 660. These laws are administered by the Farmers Home Administration. Other sources of assistance are available as follows:

A. Water and sewerage facilities grants from the U. S. Department of Housing and Urban Development (Public Law 87-117). This program provides grants of up to 50 percent of cost of land and construction of new water and sewerage facilities.



Sewage treatment plant, Socorro, New Mexico SCS PHOTO 12-P991-15

B. Program of grants of up to 50 percent and loans which may run as long as 50 years with Economic Development Administration (PL 89-136).

C. Loans up to 40 years for 100 percent of cost under Department of Housing and Urban Development (PL 84-345)

D. Grants ranging from 30 to 60 percent of costs for water treatment works through Water Pollution Control Administration.

The quantity of water in groundwater reservoirs underlying 36 of the 39 communities mentioned is adequate for projected population needs through 1980. Detailed studies will be needed for 3 of the 39 communities in order to determine adequacy of groundwater resources. These are Acoma Pueblo, Tijeras, and Magdalena. Most of these communities are in a declared underground water basin; therefore, existing water rights will have to be retired to offset any new depletions required to satisfy community needs.

Industrial Water

Demands for industrial water will vary in types of industries to be attracted to the area, relationship of industry to transportation systems, labor supplies, local initiative, and other factors -- thus, it would be difficult to "pin-point" locations to any exact degree. Projections for demands and consumptive use of industrial water are thus based on relationship of industrial water to municipal waters. Projections are as follows:

SCS PHOTO 12-P591-9

Solid Waste Disposal is an ever-present problem.

SCS PHOTO 12-P591-7

Year	Projected industrial water needs (demand) (acre-feet/day)	Projected industrial water needs (consumptive use (acre-feet/day)
1970	103.04	16.11
1980	181.24	26.42

Water for Power - Demands for water used in power generation follow the projected population increase. The projections developed reflect water demands for power whether generation is within or without the area. Projections are as follows:

Year	Projected power water needs (demand) (acre-feet per day)	Projected power water consumptive use (acre-feet per day)
1970	772.19	16.13
1980	1801.67	36.12

Solid Wastes - An ever-present and ever-increasing problem is the disposal of solid wastes. Indiscrimate dumping creates health hazards, adversely affects the quality of water from the area, is offensive to sight and smell and deters recreation and other desirable land uses. An approach to the problem is enactment and enforcement of strict laws prohibiting dumping of waste material at other than designated locations provided under the same law.

Public Law 87-703, Resource Conservation and Development Program

One of the basic objectives of the Resource Conservation and Development (RC&D) Program is the orderly development, improvement, conservation, and utilization of natural resources of the project area thereby providing employment and other economic opportunities to the people of the area. The RC&D program is applicable where the acceleration of current conservation activities plus the use of other authorities will provide additional opportunities to local people.

The area included in this report is not an authorized RC&D program area, but many of the projects proposed in the preceding pages of this report could be accomplished or assisted under Public Law 87-703.

Other measures which should be considered as potential RC&D project proposals in the Early Action Program or for additional study include:

(1) Accelerated soil surveys in those areas proposed for intensive land treatment.

(2) Accelerated conservation planning in those areas proposed for intensive land treatment.

(3) Range development - need better access to rangelands and watering facilities for better livestock distribution.

(4) Christmas tree plantations which would hire people full time in the summer and provide additional employment during the winter.

(5) Grazing associations with cattle branding, pregnancy testing, and pre-conditioning of stock included in their programs.

(6) Trout stocking of lakes and ponds.

(7) Development of small industries utilizing timber cutting and sawmill waste.

(8) Development and management of wildlife habitat.

(9) Farm and ranch training for returning veterans.

The following list includes other opportunities associated with water and related land.

(1) Scenic roads along the Continental Divide.

(2) County fairgrounds and recreation centers.

(3) Volunteer fire departments.

(4) Swimming pools.

(5) All-weather school bus routes.

The above are only a few of many project measures which would benefit the socio-economics of the area.

Land Use Planning and Zoning

A real need for comprehensive land use planning is in evidence throughout the subbasin. If New Mexico has a future in industries related to the forests, mining, and the production of meat, this subbasin may prove to be the center of activity.

Land use plans need to be developed to cope with future population and economic expansion in the area. Responsibility for this type project lies with county and municipal commissioners and state and federal planners. It is desirable that subsequent zoning laws complement future plans of state and federal agencies. Zoning boards should include county commissioners and representatives for municipalities, the State Planning Office, U. S.

Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and other organizations interested in total resource development of the subbasin. Items that should be considered are: (1) location for industrial growth, (2) areas for home sites, (3) restrictions on future use of floodplains to limit loss of life and property from floods, (4) location of garbage and refuse disposal areas, (5) areas for agricultural expansion, (6) locations for future highways and other transportation facilities, (7) sources of water and sewage disposal facilities for future domestic use, (8) location of school sites and other municipal, county, and state management facilities, (9) ideal water impoundment sites,(10) preservation of good agricultural land for agricultural purposes, (11) preservation of natural beauty spots and recreational sites, and (12) game management areas.

IV. SUMMARY OF IMPACTS

Some of the ideas and alternatives proposed in this report can be analyzed through a study of the monetary impact they will have on the subbasin. In table 8, the estimated average annual costs, benefits, and returns are listed for a few programs in which the United States Department of Agriculture can participate.

Other project measures such as Resource Conservation and Development programs, sewage, and water systems are recommended but benefits and economic impacts have not been analyzed.

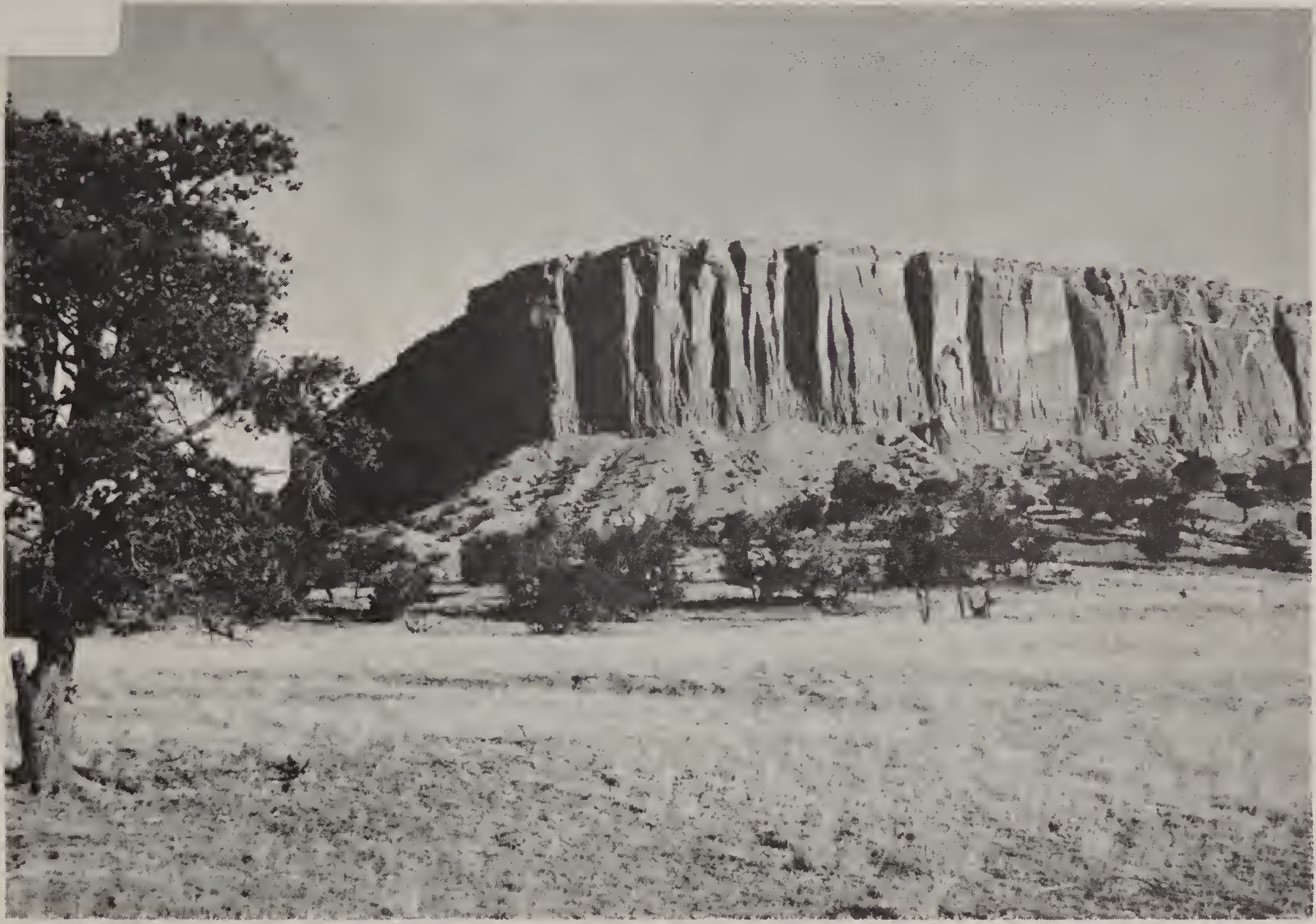
Table 8, Economic impacts under United States Department of Agriculture programs in El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Types of Measures	Early Action Opportunities: Benefits and costs: Average annual benefits for structural measures and returns on land treatment	Early Action Opportunities: Benefits and costs: Average annual cost	Early Action Opportunities: Other economic impacts: Average annual man-years of employment	Early Action Opportunities: Other economic impacts: Average annual increase in income
Structural 1/				
Canyon Sales	$ 126,700	$ 87,450	6	$ 24,000
Pajarito Arroyos	419,300	266,500	21	84,000
Pole-Zuni	37,000	23,900	2	8,000
San Mateo-Grants	111,600	95,200	6	24,000
San Jose	152,800	81,350	3	12,000
Hell's Canyon	420,000	325,700	24	96,000
Pino Draw	205,300	137,200	11	44,000
Sandias 3/	320,600	295,600	22	88,000
Lemitar-Polvadera	121,300	102,300	10	40,000
Walnut Creek	295,800	217,800	18	72,000
Nacimiento-Rito Leche	79,100	55,900	3	12,000
Corrales 2/	202,100	128,900	16	64,000
Belen-Los Lunas 5/	--	--	2	8,000
Subtotal	2,491,600	1,817,800	144	576,000
Land Treatment 4/	14,680,000	6,600,000	560	2,240,000
Total	$17,171,600	$8,417,800	704	$2,816,000

1/ These values are based on potential Public Law 566 projects
2/ This watershed has a completed work plan and approval for operations
3/ This watershed has been approved for planning and is now in progress.
4/ Based on total land treatment needs for the area covered by the El Rio en Medio Report.
5/ Inasmuch as the watershed is authorized for planning under Public Law 566 and planning for flood control works is in progress, estimates of structure data and costs for installation have not been made and will not be a part of this report.

Appendix
WATER and RELATED LAND RESOURCES
EL RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN

NEW MEXICO



Jurassic Sandstone Cliffs Near Thoreau, New Mexico SCS PHOTO 12-P935-4

PRELIMINARY
EARLY ACTION OPPORTUNITIES

A Report Based on a Cooperative Study by

THE UNITED STATES DEPARTMENT OF AGRICULTURE

and the

NEW MEXICO STATE ENGINEER

PREPARED BY
SOIL CONSERVATION SERVICE - ECONOMIC RESEARCH SERVICE - FOREST SERVICE
ALBUQUERQUE, NEW MEXICO 1970

USDA-SCS-PORTLAND, OREG. 1970

APPENDIX

EL RIO EN MEDIO SUBBASIN PRELIMINARY REPORT

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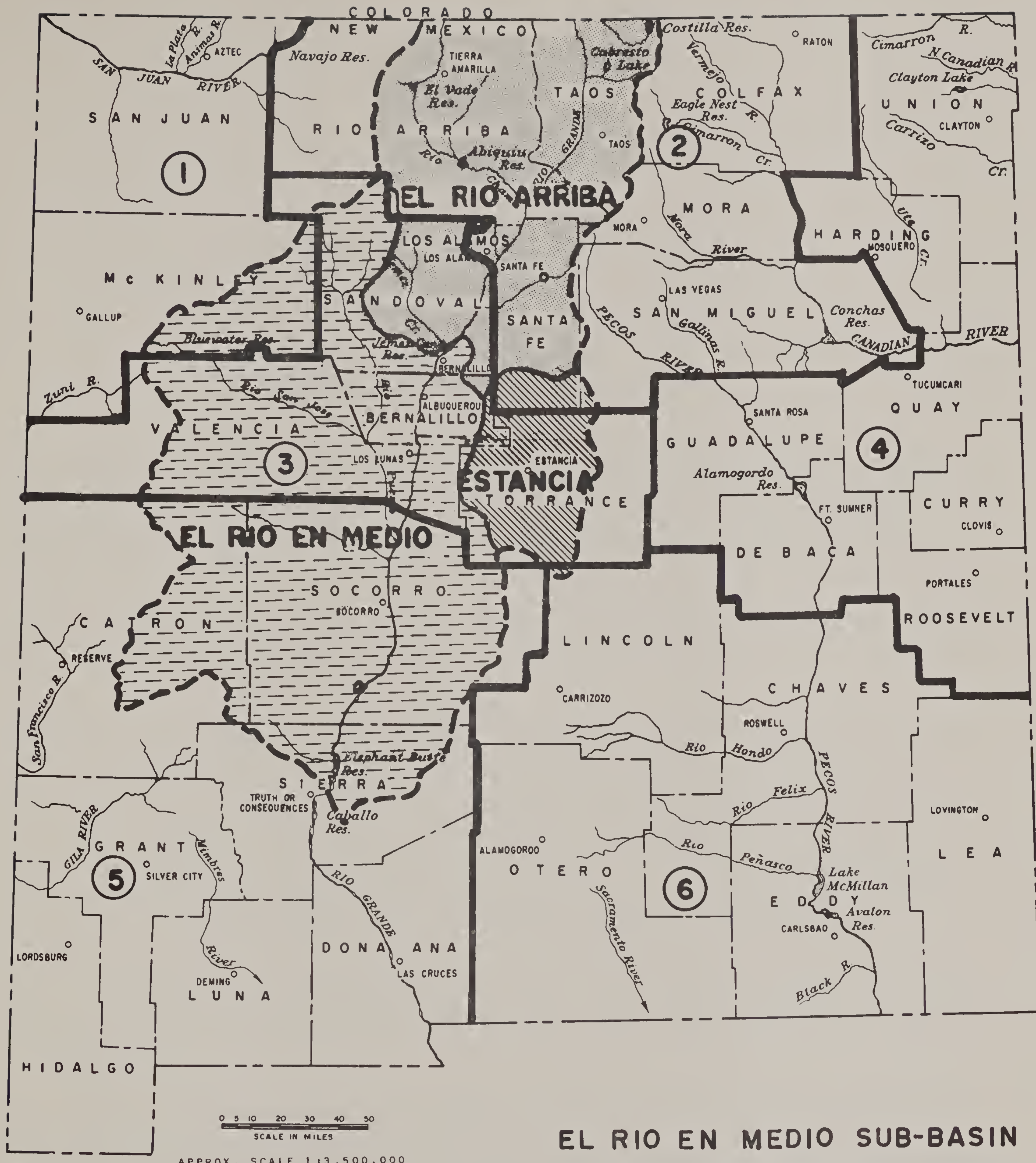


EL RIO EN MEDIO SUB-BASIN
UPPER RIO GRANDE BASIN
STATE OF NEW MEXICO
PLANNING AND DEVELOPMENT DISTRICTS

LEGEND

- ---- STATE LINE
- — — COUNTY LINE
- - - - UPPER RIO GRANDE BASIN
- ━━ DISTRICT BOUNDARY
- —— SUB-BASIN
- ② DISTRICTS

APPENDIX

PRELIMINARY REPORT

EL RIO EN MEDIO SUBBASIN

WATERSHED INVESTIGATION REPORTS

This appendix contains thirteen watershed investigation reports. These watersheds are considered for potential projects because the projects are effective and necessary solutions to the water and related land resource problems. The potential projects appear to be physically and economically feasible and should be initiated as soon as possible.

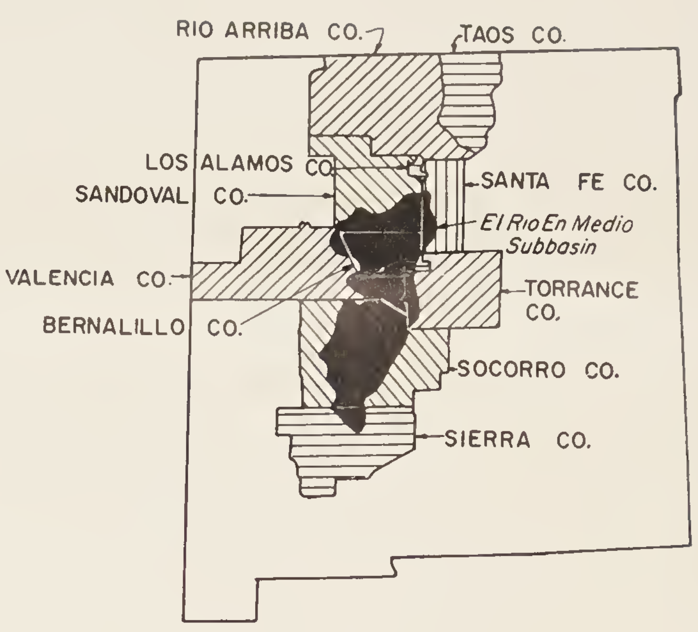
Two of the projects, the Belen-Los Lunas Watershed and Sandias Watershed, are currently being planned. One of the projects, the Corrales Watershed, has a completed watershed work plan.

Potential watersheds in this report are all interrelated. All are tributary to the Rio Grande and contribute to the quantity and quality of water in the river. Runoff and sediment yield from the watershed area is generally high. Sediment is deposited throughout the length of the river channel causing the channel bottom to aggrade, depleting available reservoir storage and will eventually cause overbank flooding. Interrelationship of the watersheds is evidenced by the extensive overlapping and intermingling of the irrigation canals and laterals.

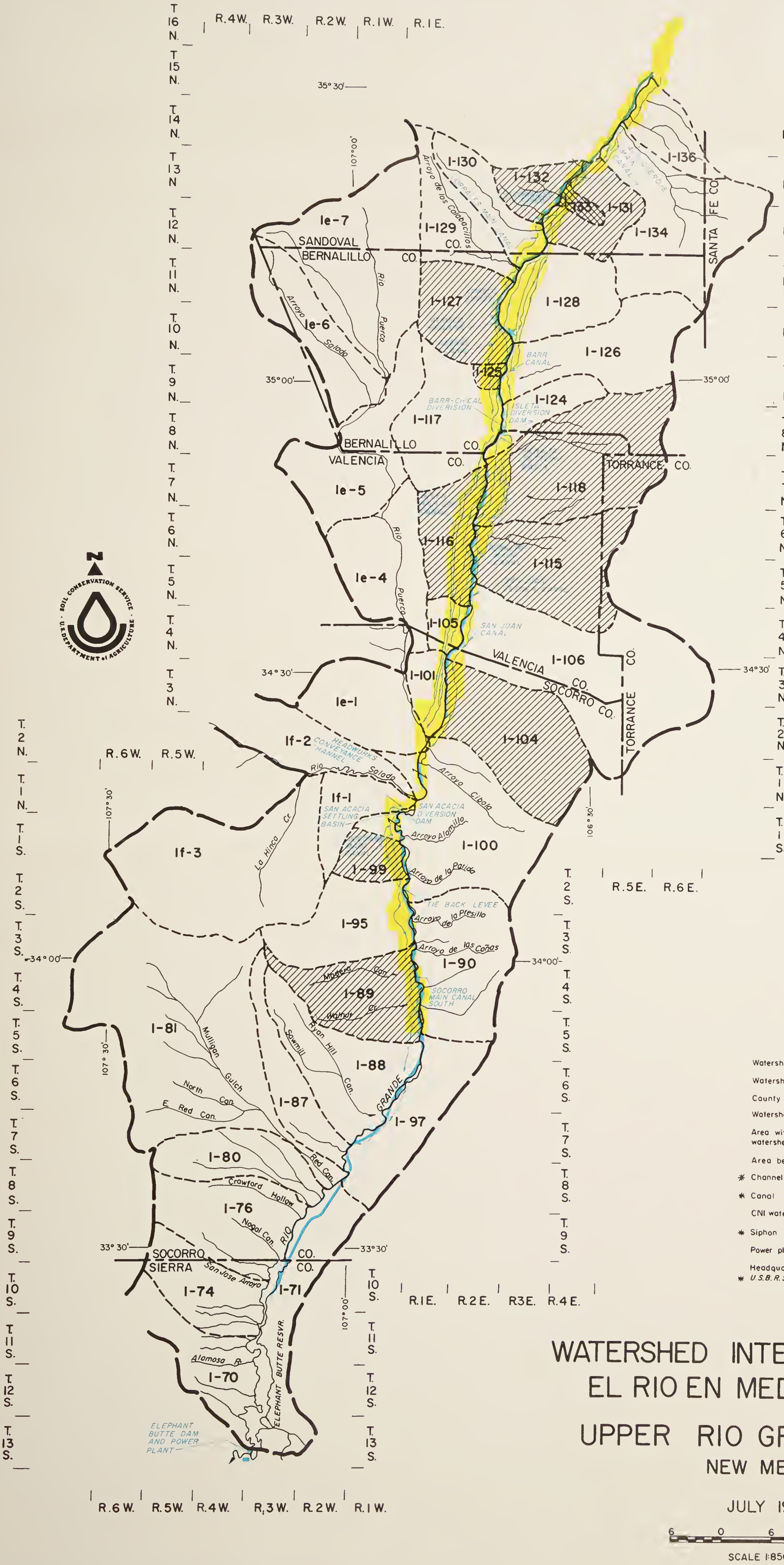
Water is diverted from the main stem of the Rio Grande by several diversions into many miles of irrigation canals. The canals convey the water to about 95,000 acres of irrigated cropland adjacent to the river and its tributaries.

This almost continuous line of canals is interrupted quite frequently by tributaries entering or overflowing into and breaking the canals. The potential watersheds in this report are of this category. For detail of canal and tributaries see El Rio en Medio Subbasin Watersheds Interrelationship Map following this page.

The San Mateo-Grants Canyon, Rio San Jose, and Pole-Zuni Canyon Watersheds are interrelated and form a combination which contributes flood flows to a common floodplain.



LOCATION MAP



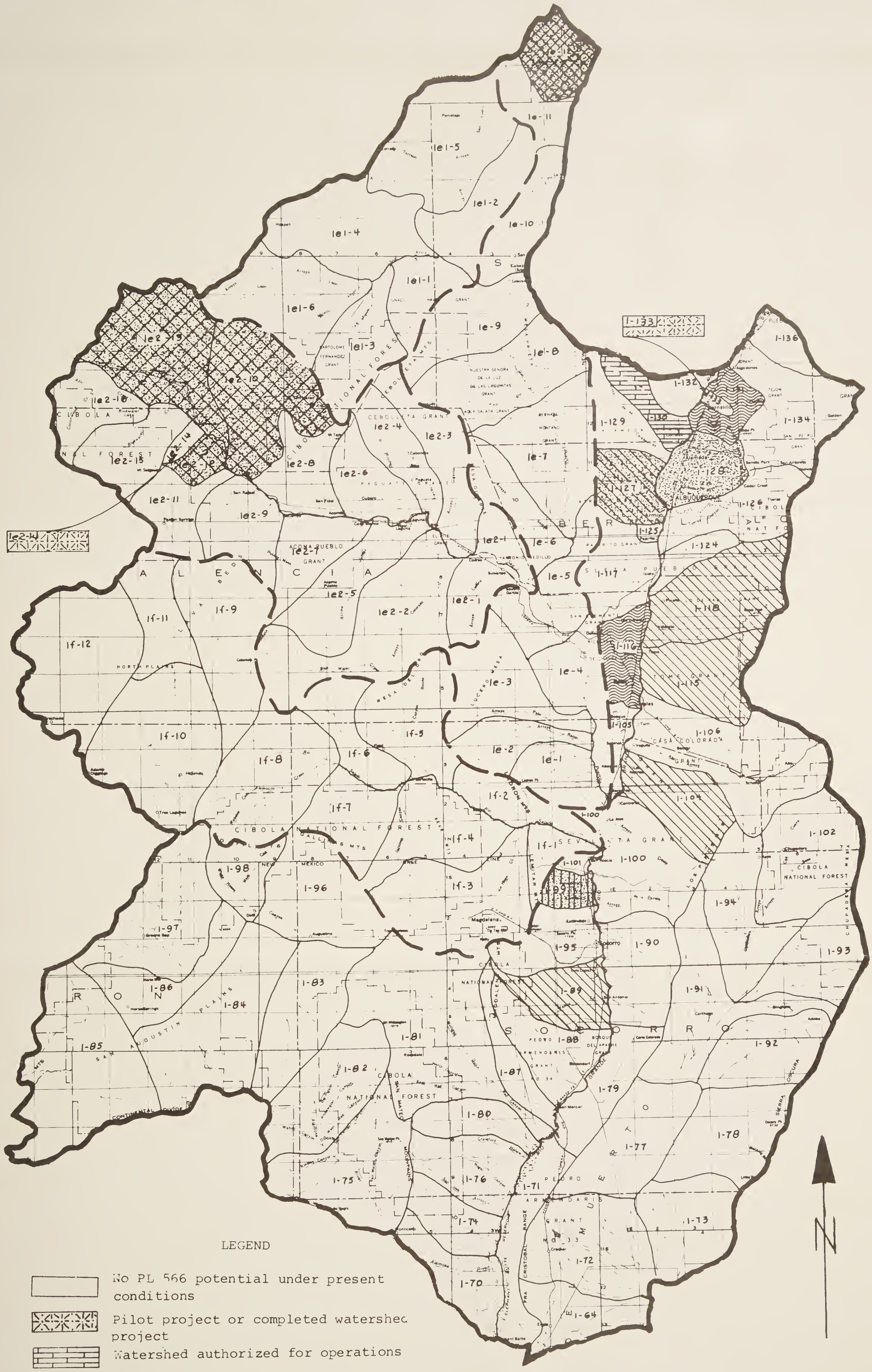
Watershed project boundary
Watershed boundary
County boundary
Watershed with potential
Area with completed watershed project
Area benefited
* Channelization
* Canal
CNI watershed no. I-97
* Siphon
Power plant
Headquarters
* U.S.B.R. Source of Irrigation Works

WATERSHED INTERRELATIONSHIP
EL RIO EN MEDIO SUBBASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JULY 1970

6 0 6 12 18 MILES
SCALE 1:850,000

M7-R-21742-N



LEGEND

No PL 566 potential under present conditions

Pilot project or completed watershed project

Watershed authorized for operations

Watershed with preliminary investigation, field examination, or river basin watershed investigation completed and having PL 566 potential

Watershed authorized for planning

Watershed work plan discontinued

Watershed application

Watershed with PL 566 potential (according to CNI data)

Watershed with application but not feasible at present time

WATERSHED MAP

UPPER RIO GRANDE BASIN

NEW MEXICO

JULY, 1970

10 0 10 20 Miles

PAJARITO ARROYOS WATERSHED

Bernalillo County, New Mexico
CNI #1-125 and 1-127

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located on the west side of the Rio Grande and includes portions of the west part of the city of Albuquerque. The north boundary is just north of U. S. Highway 66 and the east boundary, running south along the Rio Grande about 10 miles, extends just south of the Isleta Pueblo boundary line. The west boundary is the boundary between Rio Puerco and the Rio Grande. In 1960, a watershed application was submitted for assistance for flood protection in the vicinity of the community of Pajarito. The application covers an area of 51,200 acres or approximately 80 square miles in Bernalillo County.

All of the land in the watershed is privately owned. There are about 10,880 acres of irrigated cropland and residential development. All of this land is subject to floodwater damage. Numerous arroyos drain the slopes of the west mesa to the Rio Grande. Since the development of the valley area, none of the arroyos have natural outlet channels to the Rio Grande. The arroyos drain into the Gun Club Canal and drainage ditches.

The Gun Club irrigation canal furnishes irrigation water to all of the irrigated land within the watershed. The Gun Club canal is an extension of the Albuquerque Main Canal which furnishes irrigation water to land in the Sandia and Corrales watersheds which are located north and upstream of the Pajarito watershed. The canal furnishes irrigation water to farm land on the west side of the river in the Middle Rio Grande Conservancy District.

Elevations within the watershed range from about 4900 feet above sea level at the Rio Grande to about 6060 feet at the divide between the Rio Grande and Rio Puerco drainages.

Climatic conditions within the watershed are semi-arid with an average-annual precipitation of about 9 inches. The mean temperature is about 75° F. in the summer to about 34°F. in the winter.

The land use on this watershed has changed from range to urban-industrial. There are some cattle that are grazed on the watershed; however, for the most part grazing is excluded or limited and the grasslands are receiving better than average management.

The damage area of the watershed is generally from New Mexico State Highway 45 to the Rio Grande. This damage area consists of irrigated cropland and highly developed sections of residential areas. The watershed is in the Southern Desertic Basins, Plains and Mountains Land Resource Area and is within the Four-Corners Economic Development Region.

Watershed Problems and Needs

None of the arroyos have natural outlet channels to the river. The arroyos drain into the Gun Club canal filling it with sediment, overflowing the banks, and causing flooding of the area below the canal interrupting irrigation services to 5,000 acres of land. Some flooding was reported by the local people to occur every year. A substantial amount of damage to residential areas was reported in 1963, 1965, and twice in 1969. It is estimated that the 1965 and 1969 storms were about the same size with a frequency about the size of a 2-year frequency event. It is estimated under future projected conditions that a storm the size of the 1969 storm would cause about $100,000 of flood damages and the 100-year frequency flood would cause an estimated flood damage of $3,000,000.

It is projected that in 25 years the damage area will have one house per acre. There are about 7,300 acres subject to damage.

Pajarito watershed damage area includes the Rio Grande Valley and urban Albuquerque in background. SCS PHOTO 12-P1021-15

The damages mentioned above are caused by runoff from high-intensity, short duration thunderstorms. The hydrologic cover condition is poor; therefore, the runoff and sediment rates are fairly high. A portion of the damages are due to water conveyed by the canal.

Approximately 7 percent of the watershed has critical erosion problems. These are in small scattered areas generally on steep, poorly vegetated, unstable soils and in areas of heavy use near industrial urban areas. Land treatment over the total watershed area is needed in conjunction with a structural measures program to reduce the flooding of residences, crops, irrigated land, irrigation facilities and highways.

Treatment measures are needed to improve irrigation water management and enhance the productivity of the land. Throughout the main canal system and on the farms there is a need and opportunity for improving the irrigation water application systems.

Cultivated land comprises about 10 percent of the watershed. Two hundred forty acres need drainage, and 2,160 acres need improved irrigation systems.

To supplement the land treatment measures, floodwater retarding structures and outlet channels would be needed to obtain the necessary protection in the damaged area.

Physical Potential for Meeting Needs

Low precipitation, topography, and high evaporation rates make it impractical to plan permanent water for any purpose. Irrigation and drainage facilities which are maintained and operated by the Middle Rio Grande Conservancy district are considered to be adequate. It would be possible to install land treatment measures on the upper portion of the watershed area in order to help alleviate the problems. Due to the low precipitation, topography, soils, and cover, land treatment alone would not meet the desired level of protection.

The topography of the area lends itself well to locating structures on the individual arroyos; however, it is felt that a very high degree of flood protection is needed and that, possibly, the location of structures controlling more than one arroyo would be the most economical method of flood prevention in this area.

Potential structure sites are located in the Santa Fe Group of geologic strata and would present no unusual installation or maintenance problems. However, outlet works for the structures would present a problem as they would need to traverse highly developed residential and expensive irrigated land. Therefore, it is felt the use of existing irrigation facilities would be the most logical method of conveying the water from the principal spillway of the structures to the river.

Local Interest in Project Development

A watershed application was submitted for assistance under Public Law 566 in 1960. In July of 1962 a preliminary investigation report was made which indicated that a feasible project could be developed and justified. It was recommended that the sponsors organize a watershed district to handle easements and rights-of-way, operation and maintenance, and other responsibilities to be carried out by the local people. At this time, the Albuquerque Flood Control District has agreed to assume these responsibilities and carry out the financial responsibilities of the local organization.

The application as submitted does not cover the whole problem area. It is recommended the application be amended to include the additional area to the north and south as shown on the accompanying map.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Good range management on 640 acres of grassland. Grazing management is essential to all areas still used for range. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Effective drainage systems on 240 acres of crop, pasture, and hayland.

(c) Improved irrigation facilities on 2,160 acres of irrigated land.

(d) Erosion control on 3,370 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in areas of heavy use near industrial urban areas. Effective methods that may be used on land subject to critical erosion are small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils so protective stands of vegetation will result from grass seeding.

Structural Measures

Potential structural measures designed for flood protection within this watershed include five floodwater retarding structures and three floodwater diversions. A lined channel would carry the principal spillway discharge from the potential structure site 1 to the Rio Grande. The principal spillway discharge from the other four potential floodwater retarding structures would be carried by lined channel to the Isleta Drain. The capacity of the drain would be increased to handle the flood flows to a point near the Isleta Indian Reservation where a new channel would be constructed directly to the river.

The potential structures would be single-purpose flood control structures. They would control floods on about 55 square miles of a 62 square mile area presently contributing to flood damages. See watershed map for structure locations and tables 1, 2, 3, and 4 for structure details.

Throughout the main canal system and on the farms there is an opportunity for improving the irrigation water application systems. Most of the on-farm improvements could be applied on a watershed basis; however, the entire delivery system should be analyzed throughout the conservancy district. This planning and installation of improvements could best be accomplished by a joint federal agency, New Mexico State Engineer, and local water users effort. For this report no specific items of improvement are identified or evaluated.

Nature and Estimate of Costs of Improvements

Investigation of the watershed was made at a reconnaissance level. A field reconnaissance was made using aerial photos and 1:24,000 U. S. Geological Survey quad maps. Potential structure sites were checked on site and on the quad sheets. Structure location on the quad maps was used to estimate structure capacity and the required earth embankment. Items of work would be earth embankment and reinforced concrete chute emergency spillways for five floodwater retarding structures, earth excavation and embankment in 4 floodwater diversions, earthwork for cleaning and enlarging the Isleta drain and constructing a channel to the river from the drain. Concrete-lined channels are proposed as principal spillway discharge channels from each structure to the drain. Several bridges and/or culverts on highways would be required.

The estimated cost of construction and installation services was made by applying a unit cost to the estimated embankment volume. This unit cost value was taken from curves developed from detailed data prepared for Public Law 566 projects in New Mexico. Other estimated costs are based on preliminary design for quantities from map data and applying current unit cost values to these quantities.

The area where the potential structures would be located is all privately owned. Obtaining land and easements should not present a problem. Land costs will be high and will be a significant part of the cost of the project. Under present conditions no major roads or utility lines would need to be changed or moved.

Effects and Economic Feasibility of Potential Development

The installation of the needed structural measures would provide a high degree of protection to about 7,300 acres of land. Most of this land is expected to be in urban use within 25 years.

The installation of structural measures would control about 89 percent of the drainage area and would reduce present damages by approximately 92 percent. With a fully developed urban area and without flood control measures, the average annual damage is estimated to be $371,000. These damages could be reduced to about $30,000 annually with the installation of project measures. The resulting damage reduction benefits would be $341,000.

Redevelopment and secondary benefits associated with the installation, operation, and maintenance of the project measures would be about $78,300 on an annual basis. The total project benefits are estimated to be $419,300; and when compared to the average annual cost of structural measures, a benefit-cost ratio of 1.6 to 1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures primarily designed to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $37,900. The average annual returns are estimated to be $108,800.

This project, if installed, would enhance environmental control by reducing sediment yield to the Rio Grande and reducing dust particles in the air.

Alternative and Additional Possibilities

This report includes structural measures which are considered feasible. There are alternate site locations on each of the arroyos. These alternate structure sites should be considered in detail in planning.

To eliminate the flood hazard caused by the canal, possibly a study to determine the feasibility of constructing an underground conveyance system is needed. This would have to be done on something broader than a watershed by watershed basis.

Table 1, Structure data, Pajarito Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surface area em. spill. area	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	34.2	36	1,360,593	RC conduit	8	RC chute	1.0	255	c
2	9.1	23	349,000	RC conduit	8	RC chute	1.0	180	c
3	5.7	31	487,900	RC conduit	8	RC chute	1.0	120	c
4	2.8	32	191,326	RC conduit	8	RC chute	1.0	40	c
5	3.7	19	237,978	RC conduit	8	RC chute	1.0	65	c

Table 2, Reservoir storage capacity, Pajarito Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin

Site number	Drainage area	Storage capacity planned		
		Sediment	Detention	Total
	(sq. mi.)			
1	34.2	1,117	2,700	3,817
2	9.1	234	900	1,134
3	5.7	209	450	659
4	2.8	166	220	386
5	3.7	149	290	439

Table 3, Channel data, Pajarito Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach (100 ft.)	Watershed area (sq.mi.)	Needed chan. cap. (cfs.)	Bottom width (ft.)	Depth (ft.)	Velocity in channel (ft/sec)	Estimated vol. of fill or ex. (cu.yd.)
FWD 1a	73	2.35	2,600	300	4.2	4.0	181,200
FWD 1b	93	10.65	5,325	450	4.5	5.0	366,800
FWD 2 (Dike)	75	2.26	2,486	-	5.0	-	18,000 (fill)
FWD 3	18	5.70	1,463	100	5.0	3.0	37,000
Channel 100	115	-	280	4	4.5	15.0	conc. lined
Channel 200	46	-	93	4	3.0	9.0	conc. lined
Channel 300	32	-	46	3	3.0	6.0	conc. lined
Channel 400	20	-	33	2.5	3.0	5.0	conc. lined
Channel 500	27	-	30	2.5	3.0	5.0	conc. lined
Isleta Drain	366	-	250	15	5.0	3.0	75,000

Table 4, Distribution of structural cost-potential development, Pajarito Watershed, Upper Rio Grande Basin, El Rio en Medio Subbasin, New Mexico (dollars) 1/

Structural Measures	Installation Cost				
	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Floodwater retarding structures					
Site 1	970,000	323,000	300,000	1,000	1,594,000
Site 2	341,000	113,000	190,000	1,000	645,000
Site 3	355,000	153,000	140,000	1,000	649,000
Site 4	160,200	67,000	24,500	500	252,000
Site 5	186,000	80,300	39,500	500	306,000
Floodwater Diversion 1a	163,000	54,000	41,500	500	259,000
1b	330,000	110,000	38,500	500	479,000
2	15,000	6,000	109,000	500	131,000
3	19,000	6,000	1,500	500	27,000
Principal Spillway Outlet Channel					
Channel 100	235,000	94,000	53,500	500	383,000
Channel 200	35,000	16,000	12,500	500	64,000
Channel 300	24,000	12,000	11,500	500	48,000
Channel 400	14,000	6,000	4,500	500	25,000
Channel 500	18,000	7,000	4,500	500	30,000
Isleta Drain	69,700	35,300	41,500	500	147,000
Totals	2,935,000	1,082,000	1,013,000	9,000	5,039,000

1/ Price base: 1969

Table 5, Annual Cost, Pajarito Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Amortization of install. cost 1/	O & M cost 2/	Total annual cost
Floodwater retarding structures 1, 2, 3, 4, and 5; and all channel improvements	247,800	18,700	266,500

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

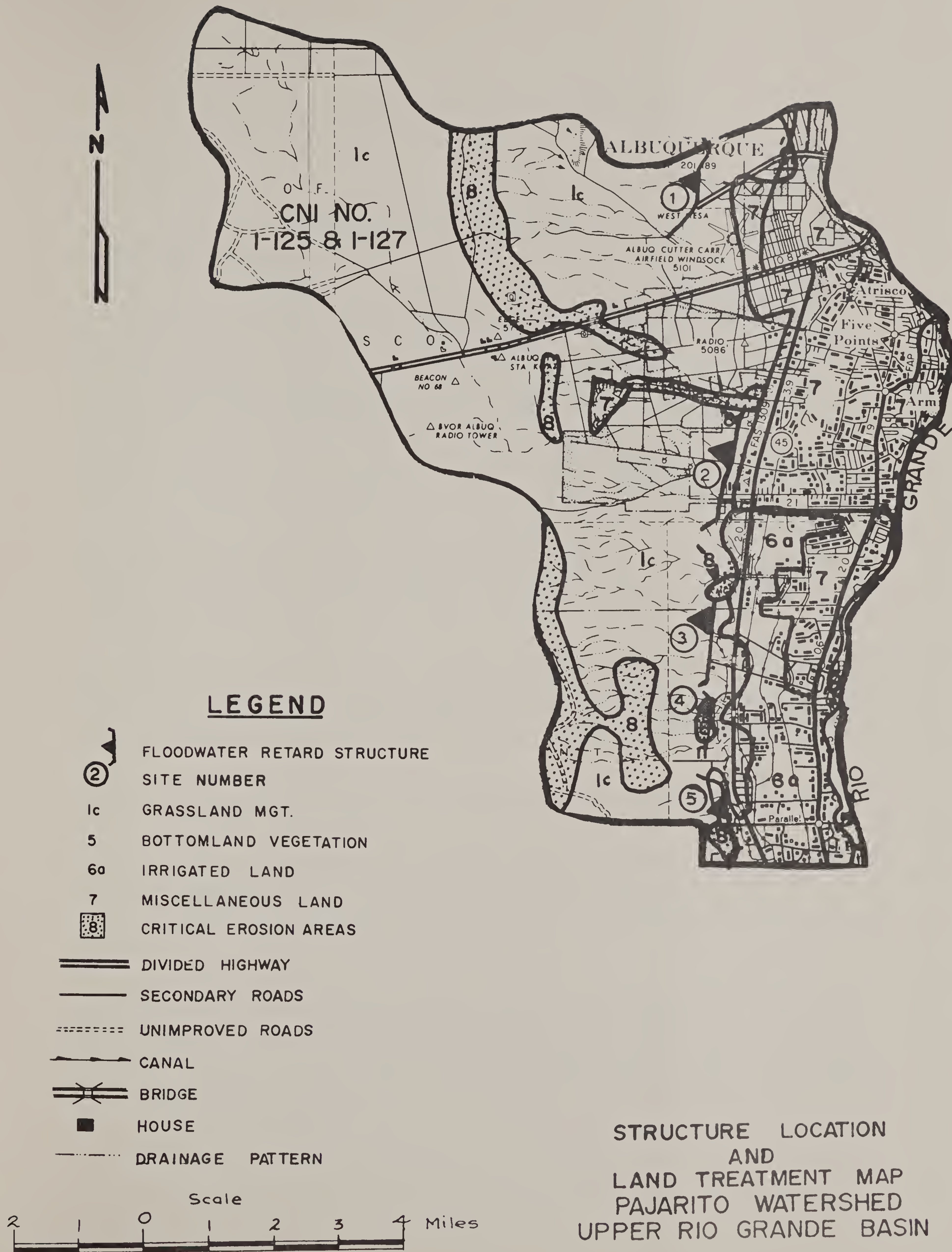
Item	Est. average annual damage		Damage reduction benefits
	Without project	With project	
Floodwater - urban	371,000	30,000	341,000

1/ Based on adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits				Average annual cost	Benefit cost ratio
	Flood prev. damage red.	Redevelopment	Secondary	Total		
Floodwater retarding structures 1, 2, 3, 4, and 5, and channel imp.	341,000	47,400	30,900	419,300	266,500	1.6:1

1/ Adjusted normalized prices



STRUCTURE LOCATION
AND
LAND TREATMENT MAP
PAJARITO WATERSHED
UPPER RIO GRANDE BASIN

H E L L ' S   C A N Y O N   W A T E R S H E D

Valencia and Bernalillo Counties, New Mexico

CNI #1-118

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located about 10 miles south of Albuquerque and includes parts of Bernalillo and Valencia Counties, New Mexico. The watershed comprises 183,872 acres (287.3 square miles). Land status in the watershed is 22,855 acres of public land, of which 9,722 acres are administered by the Forest Service, 2,253 acres by the Bureau of Land Management and 10,880 acres are military reservation; 54,122 acres are privately-owned; 103,444 acres are Indian land; and 3,451 acres are state land.

Land use is about 119,000 acres of grassland, 51,000 acres of woodland, 750 acres of bottomland vegetation, and 12,000 acres of irrigated cropland.

The relief pattern is to the west, draining the west slopes of the Manzano Mountains which form the eastern watershed boundary. The west boundary extends about 12 miles along the Rio Grande. Several small communities are within the watershed. State Highway 47 traverses the watershed from north to south.

Sea level elevations range from 4,900 feet at the Rio Grande to almost 10,000 feet in the Manzano Mountains. Topography in the mountain area is steep and rough. The rest of the watershed has a gentle slope westward to the brakes on the east side of the Rio Grande. The bottomlands are nearly level.

Climatic conditions are semi-arid with an average annual precipitation of about 8 inches at Belen and about 25 inches in the mountains.

Temperatures in the valley range from a high of 104° F. to a low of -5° F., with an average of 57° F. Average frost-free period is 166 days from May 5 to October 15. Most of the precipitation occurs as rainfall from convective-type summer thunderstorms, usually of high intensity and short duration.

Arroyos in the watershed originally had channels with outlets into the Rio Grande channel. In recent years, however, the broad flat bottomland along the Rio Grande has been developed into highly productive cropland. As the bottomland was developed, the arroyos were leveled and now terminate and empty into the main irrigation canal. Channels to convey flood flows to the river are non-existent.

The watershed is within the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. It is included in the Mexican Highland Section of the Basin and Range Physiographic Province. The range condition is fair, but the hydraulic cover condition over most of the area is poor.

Erosion rates vary up to 4.0 acre-feet per square mile per year in the "badlands" section of the watershed.

Of the 5,000 acres of National Forest administered land in the watershed, about 1,000 acres are classed as commercial and 4,000 acres as non-commercial forest.

Watershed Problems and Needs

Floodwater and sediment damage roads, residences, irrigation facilities, farm equipment, and irrigated cropland. High-intensity, short-duration thunderstorms falling on rangeland with poor hydrologic cover conditions and steep, rough topography, concentrate the runoff quickly, causing large peak discharges in the arroyos. These conditions make the watershed area susceptible to severe erosion. Approximately 2 to 3 percent of the watershed has critical erosion problems.

Floodwater from the arroyos flows directly into the main irrigation canal. The canal fills with sediment which causes the canal to break and inundate the irrigated cropland. About 700 acres of crops and cropland are damaged every year from floods. Damages from interrupted irrigation services occur on an additional 4,000 acres of land.

Where county roads cross arroyos they receive damage from being either washed out or filled with sediment. Damage of this type occurs in the watershed annually.

There are approximately 400 farm homes, small businesses, and rural non-farm residences subject to flooding. The agricultural area flooded by the 1 percent chance storm event is estimated to be 9,400 acres. Agricultural damages to crops and pastures amount to about $139,400 annually. Other agricultural damages requiring repairs to irrigation canals, and roads and bridges and releveling land are estimated at about $24,200. Average annual damage to urban development is estimated at $146,000. Indirect damages associated with flooding are estimated to be $31,000 annually. The sum of all of these damages amounts to $340,600 per year.

There is a need for improved land treatment and other flood prevention measures to control the floodwater and sediment discharged from the arroyos.

Land treatment on the irrigated cropland is needed to improve water management and lower water tables in some locations.

Heavily used range encourages snake weed encroachment and exposure of erodable soils. SCS PHOTO 12-P1021-4

The entire irrigated area of the watershed is in the Middle Rio Grande Conservancy District. The district operates and maintains the major canals and delivery systems. There is a need for some additional water control structures in the system, and in some areas canal lining would be of value.

Many of the laterals and on-farm ditches need to be lined and have control structures installed. For this investigation report, specific sites for lining and structures have not been identified.

The entire irrigated area needs to be investigated and a reorganization planned in conjunction with the conservancy district irrigation systems.

Physical Potential for Meeting Needs

Due to the low average annual precipitation and high evaporation rate, permanent water storage for any purpose is not considered feasible. However, there are many locations with potential for developing picnic and camping areas, both near the Rio Grande and in the mountains.

There are adequate locations for floodwater retarding structures to control floods originating in the watershed. Field investigations indicate adequate borrow of sand and some clay for construction. Cutoff depths will be less than 20 feet and all excavation will be common. Some scour will occur in unlined outlet channels flowing across silty sands.

Numerous possible structure locations are to be found upstream from the ones located in this report. However, the upstream locations would lessen the control and increase the cost of outlet channels.

Local Interest in Project Development

The people contacted were aware of the floodwater problem and were interested in finding a solution. The people are conservation-minded and most of them participate in the installation and application of needed conservation practices.

At this time, there is no legal organization for the installation, operation, and maintenance of a PL 566 project. Local people feel that such an organization could be formed if the flood control measures were economically feasible. The district conservationist and soil and water conservation district should encourage the people to obtain legal organization to sponsor a project.

Works of Improvement For Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Good range management on 52,439 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 2,335 acres of land

(c) Phreatophyte control on 384 acres of land.

(d) Effective drainage systems on 1,697 acres of crop, pasture, and hayland.

(e) Improved irrigation facilities on 7,575 acres of irrigated land.

(f) Management of 100 acres of abandoned cropland.

(g) Erosion control on 4,955 acres of critically eroded land. These areas are generally on the steep, poorly vegetated, unstable soils on the breaks just east of the high irrigation canal and in areas of heavy use near farmsteads and urban development. Soils, climatic, and topographic conditions team up in the lower elevations of this

watershed to make land treatment difficult and expensive but not impossible. Effective methods that may be used to control erosion are small gully plugs, net wire fences, contour furrows and diversions in an attempt to stabilize the soils so grass seeding will result in protective stands of vegetation.

Needs for timber stand improvement vegetative manipulation and erosion control are listed in the National Forest Project Work Inventory and should be given consideration in preparation of the work plan.

Structural Measures

To meet the needs of flood control in the watershed, five potential retarding structures are proposed. Because there are no existing channels to the river, outlet channels would have to be installed with each structure to convey the principal spillway discharges to the river. Based on this investigation, it is felt that the use of irrigation canals and drainage ditches would be the most feasible approach as it would contribute to both flood prevention and agriculture water management. These channels would discharge into existing drains and wasteways to the Rio Grande.

The potential structures would be single-purpose flood control units. Part of the structures would be long embankments to provide maximum protection from the numerous arroyos emptying into the area.

Nature and Estimate of Costs of Improvements

Investigation of the watershed was at a reconnaissance level. U. S. Geological Survey quadrangle maps (1:24,000 scale) and aerial photos of the area were used and supplemented by a field reconnaissance of possible site locations. Data was developed from the quad maps to estimate the capacity of the potential structures and also to determine the estimated volume of fill material needed for an embankment to store the required sediment and floodwater.

The principal item of construction would be earth embankment and concrete for the five floodwater retarding structures. Each will have a reinforced concrete conduit with associated controls for a principal spillway. The outlet channels would have control structures where they drop into the drain or wasteway and structures at canal and road crossings. The estimated construction and installation service cost was determined by applying a unit cost figure to the estimated volume of embankment. This unit cost figure is taken from curves developed from data on PL 566 projects where detailed quantities and costs were developed. These detailed estimates were made for structures in areas similar to this watershed. Other cost figures were developed from figures obtained from a preliminary design for the facility. A power pole line will have to be relocated through three of the proposed structures. This estimated cost is included in land rights costs in table 3.

Land rights costs were estimated using current values for the land and present use of the area. Obtaining necessary easements and rights-of-way for the structures should not present a problem.

Effects and Economic Feasibility of Potential Development

The installation of the proposed structural measures would provide a significant degree of flood protection to approximately 12,000 acres of irrigated land and to about 400 farm houses, rural residential units, and small business establishments. In addition, irrigation facilities serving about 4,000 acres of land below the watershed would be protected from frequent damage.

After the project measures are installed, damages will be reduced to about $17,000 annually, a reduction of 95 percent. This will result in average annual damage reduction benefits of $323,600. Redevelopment and secondary benefits associated with the installation of project measures are estimated to be $96,450 annually. The sum of all project benefits evaluated amounts to $420,050. The average annual cost of structural measures including operation and maintenance amounts to $325,720.

When average annual benefits are compared to average annual cost, a benefit-cost ratio of 1.3 to 1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures primarily designed to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $195,900. The average annual return is estimated to be $780,400.

Alternate or Additional Possibilities

There are several alternate ways and routes that the discharge from the principal spillways can be carried to the Rio Grande: the channels could be taken directly to the river across the valley floor, other combinations of discharge and routes across the valley to the river, or the possibility of using channels with control structures in an unlined channel.

Additional water management and irrigation system development is a possibility and a need exists for this development. These possibilities were not considered in the report, but should be investigated when a firm project plan is being developed.

Potential damage area below arroyo, Hell's Canyon Watershed

SCS PHOTO 12-P1020-14

Table 1, Structure data, Hell's Canyon Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway: Type	Principal spillway: Release rate	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surf. area em. spill. level	Hazard class
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	144.8	70	1,114,000	RC conduit	8	RC chute	1.0	325	c
2	60.9	39	3,123,000	RC conduit	8	RC chute	1.0	260	c
3	5.7	25	307,000	RC conduit	8	RC chute	1.0	46	c
4	22.6	42	1,022,000	RC conduit	8	RC chute	1.0	97	c
5	29.3	27	801,000	RC conduit	8	RC chute	1.0	180	c

Table 2, Channel data

Channel designation	Length of reach	Needed channel capacity	Bottom width	Depth	Velocity in channel	Estimated volume of excavation
	(100 ft.)	(cfs.)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
Principal spillway outlet channels						
Channel 100	28	1,160	90	4.4	3.0	40,500
200	10	488	46	3.5	3.0	6,100
300	5	48	3	2.5	8.0	conc. lined
400	30	184	24	2.8	3.0	6,900
500	5	240	28	2.9	3.0	3,900

Table 3, Reservoir Storage Capacity, Hell's Canyon Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Storage capacity planned: Sediment	Detention	Total
	(sq. mi.)	- - - - - - acre feet - - - - - - - -		
1	144.8	991	8,506	9,947
2	60.9	613	3,598	4,200
3	5.7	85	351	436
4	22.6	232	1,333	1,565
5	29.3	230	1,733	1,963

Table 4, Distribution of structural cost-potential development (dollars) 1/

Structural measures	Installation cost: Construction	Installation services	Land, easements and RW 2/	Administration of contracts	Installation cost
Floodwater retarding					
structures Site 1	1,303,000	560,000	5,500	500	1,869,000
2	1,535,000	660,000	50,000	1,000	2,246,000
3	216,000	93,000	10,000	1,000	320,000
4	650,000	280,000	4,000	1,000	935,000
5	490,000	211,000	7,000	1,000	709,000
Outlet channels					
Channel 100	59,000	20,000	16,000	2,000	97,000
200	12,000	11,000	17,500	500	41,000
300	3,000	1,000	1,500	500	6,000
400	9,000	7,000	16,000	1,000	33,000
500	8,000	5,000	10,500	500	24,000
	4,285,000	1,848,000	138,000	9,000	6,280,000

1/ Price base: 1969
2/ Land easement costs include costs of utility line changes and non-federal costs in channel construction

Table 5, Annual cost, Hell's Canyon Watershed El Rio en Medio Subbasin Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
FRS 1, 2, 3, 4, 5 and channel improvements	308,790	16,930	325,720

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

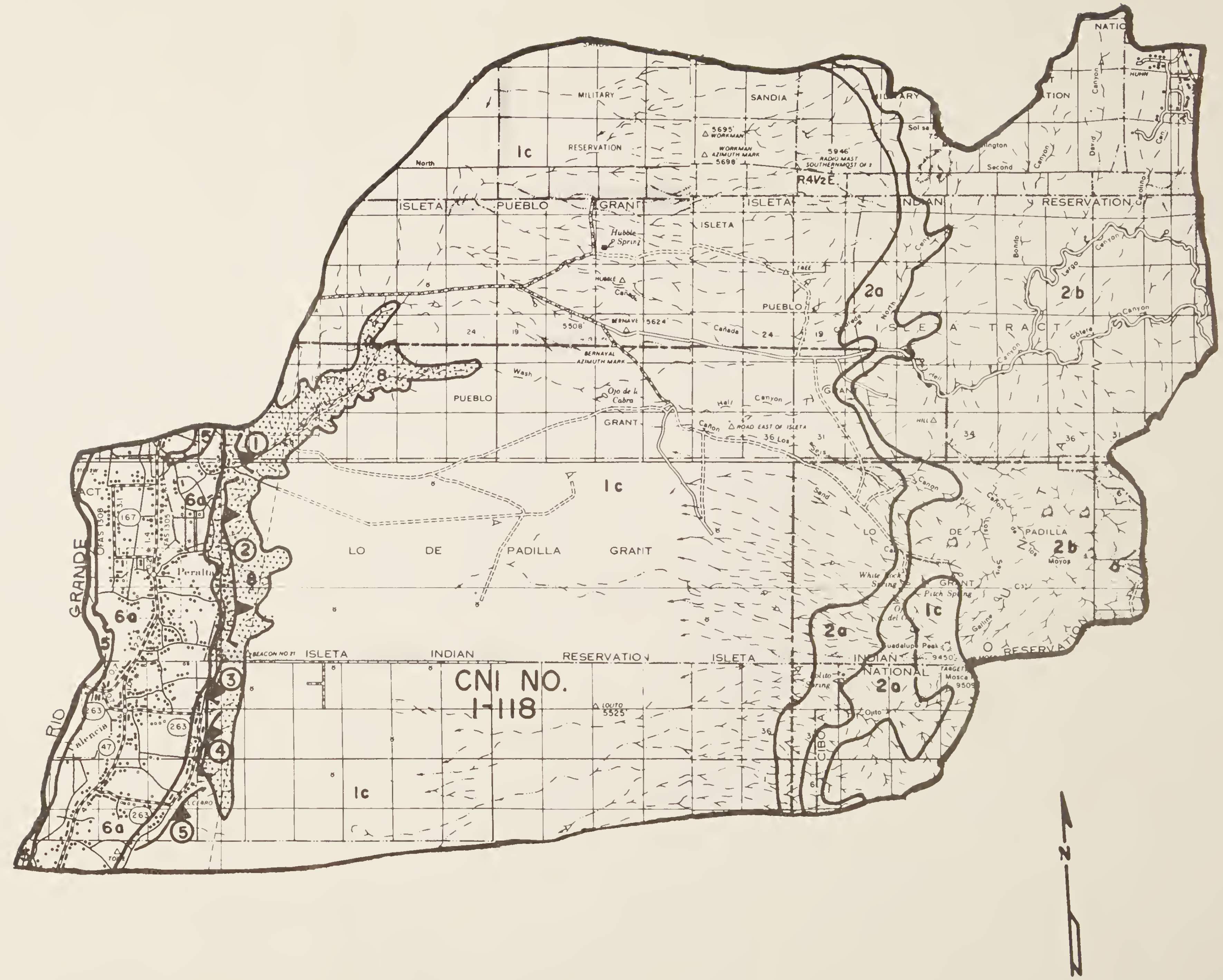
Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater			
Agricultural			
Crop & pasture	139,400	7,000	132,400
Other agricultural			
Irr. canals & land leveling	24,200	1,200	23,000
Urban	146,000	7,300	138,700
Indirect	31,000	1,500	29,500
Total	340,600	17,000	323,600

1/ Based on adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Redevelopment	Secondary	Total	Average annual cost	Benefit cost ratio
FRS 1, 2, 3, 4, 5 & channel improvements	323,600	66,880	29,570	420,050	325,720	1.3:1

1/ Adjusted normalized prices



LEGEND

- FLOODWATER RETARD STRUCTURE
- ② SITE NUMBER
- 1c GOOD RANGE MGT.
- 2a PINYON-JUNIPER CONTROL
- 2b PINYON-JUNIPER MGT.
- 5 BOTTOMLAND VEGITATION MGT.
- 6a IRRIGATED LAND MGT.
- 8 CRITICAL EROSION AREA
- COUNTY BOUNDARY
- PAVED HIGHWAY
- SECONDARY ROADS
- UNIMPROVED ROADS
- DRAINAGE PATTERN
- HOUSE

Scale

2 1 0 1 2 3 4 Miles

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
HELL'S CANYON WATERSHED

UPPER RIO GRANDE BASIN

C A N Y O N   S A L E S   W A T E R S H E D

Valencia County, New Mexico
CNI #1-115

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed in located in the east central part of Valencia County, New Mexico. The north boundary is about 26 miles south of Albuquerque. The west boundary extends about 8 miles south along the Rio Grande, and the south boundary extends eastward along the divide north of Abo Arroyo. The watershed boundary on the east is along the crest of the Manzano Mountains. For more detailed information see the watershed location map.

State Highway 47 traverses the watershed north to south. State Highway 6 runs southeast from Los Trujillos. The communities of Tome, Adelino, La Constancia, and Los Trujillos are within the watershed which includes an area of about 147,100 acres (229.9 square miles). The drainage pattern is generally to the west. In recent years the land in the floodplain area has been leveled and developed into highly productive irrigated cropland. In the process of leveling the land, the arroyo channels were also leveled, consequently, the arroyos drain into the main irrigation canal and have no channels to the river.

Land status in the watershed is 118,300 acres of private land, 1,200 acres of public land administered by the Bureau of Land Management, and 27,600 acres administered by the Forest Service. Of the 27,600 acres of National Forest administered land in this watershed about 3,000 acres are classed commercial and 24,600 acres non-commercial forest.

There are approximately 4,200 acres of irrigated cropland, 21,700 acres of woodland, 55,300 acres of sagebrush, 64,300 acres of grassland, and 1,600 acres of miscellaneous land.

Sea level elevations range from 4800 feet at the Rio Grande to about 9000 feet at the crest of the Manzano Mountains.

The watershed is in the Southern Desertic Basin Land Resource Area. It is included in the Mexican Highland Section of the Basin and Range Physiographic province. Erosion rates vary up to 1.0 acre feet per square mile per year in the watershed.

The average annual temperature is 57° F. at Belen with a high of 97° F. and a low of -7° F. The average annual rainfall is 7 inches at Belen. Evaporation rates in this locality are high. High-intensity short duration, convective-type summer thunder storms occur quite frequently in this vicinity.

Watershed Problems and Needs

Since arroyos have no outlets to the river, they overflow the canal, flooding the irrigated farmland below. Local people reported some flood damage to occur every year. About every three years approximately 1,000 acres of land are damaged to the extent that crops are lost and the land has to be releveled. When floods occur, about 1,000 acres of irrigated cropland suffer damage because canals become filled with sediment and water cannot be delivered to the fields.

Several homes in the watershed suffer damage by floodwater almost every year. Highways are damaged annually and a four-mile section of State Highway 47 has to be cleaned every time the arroyos run. About 4 miles of county road is damaged and must be repaired annually. The hydrologic cover condition is poor; therefore, the runoff and sediment rates are fairly high.

Flood damages, caused on the average of about every three years, are estimated at $15,000. A 100-year frequency storm would cause an estimated $200,000 of damage to roads, highways, residences, irrigation facilities, crops and cropland.

This area is in need of land treatment and flood prevention measures to reduce the floodwater and sediment damage to residences, businesses, highways, canals, crops, cropland, and deterioration of rangeland conditions. Subsurface drainage is needed on 420 acres, and 2,600 acres need improved irrigation water management.

Physical Potential for Meeting Needs

Any type of surface water storage is not considered feasible due to the low average annual precipitation, high evaporation rate and the absence of suitable structure locations.

Land treatment measures which would help decrease the flood damages and increase soil cover and productivity of the land are physically possible. To achieve the flood protection desired, other structural measures will be necessary.

In the area where structures are needed, the topography is quite level in the north-south direction and does not lend itself well to the installation of floodwater retarding structures. However, due to high cost of channelization, it is felt that retarding structures would be the most economical method of flood prevention.

Typical sand sage vegetation and irrigated land subject to floodwater and sediment damage. Canyon-Sales Watershed. SCS PHOTO 12-P1021-6

Soil material at all potential structure sites is rated as fair to good construction material. Surface investigations of the foundations and abutments were made at each structure location. Potential sites are located in quaternary age terrace deposits underlain by Santa Fe Group geologic strata. Foundations have adequate bearing strength and adequate borrow of SC, SP, and SM. All excavation should be common and cutoffs at less than 20 feet. Unlined channels in sand, silt, and clay in the floodplain will probably scour.

Local Interest in Project Development

The individuals contacted during the field investigation are aware of the flood hazard within this watershed. They are interested in trying to find a means to control floodwater from the arroyos, and are aware of the need for agricultural water management. Much of the land is leveled and many concrete-lined irrigation ditches have been installed. The conservation program is active in this area but with flood protection would proceed more rapidly.

The local people feel they would encounter few difficulties obtaining support to finance their cost of a watershed project.

It is recommended that the district conservationist and the soil and water conservation district work with these people, and that a legal sponsoring organization be formed or existing organizations such as the county commission be approached for sponsorship of such a program.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Soil, climatic, and topographic conditions team up in the lower elevations of this watershed to make land treatment difficult and expensive, but not completely impossible.

Systems include:

(a) Good range management on 30,418 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Phreatophyte control on 80 acres of bottomland.

(c) Effective drainage systems on 420 acres of crop, pasture, and hayland.

(d) Improved irrigation facilities on 2,680 acres of irrigated land.

The National Forest project work inventory lists needs for vegetative management, erosion control and timber stand improvement all of which should be considered in work plan formulation.

Structural Measures

From a map and field reconnaissance determination has been made that three floodwater retarding structures are needed to provide an adequate level of flood protection to the area. Potential structures would all have associated outlet channels for principal spillway discharge. The potential structures are single purpose flood prevention. Existing drains and wasteway would be used to discharge the principal spillway flow to the river. Costs and quantities are shown in tables 1, 2, 3, and 4.

The district maintains and operates the major irrigation canals and delivery system. Many of the laterals and on-farm ditches could be reorganized, lined, and adequate control structures installed. This investigation and report does not identify or evaluate specific systems that need to be developed.

Nature and Estimate of Costs of Improvements

The investigation and estimates for this watershed are of reconnaissance level intensity. U. S. Geological Survey quadrangle maps and aerial photos were used with a field reconnaissance to determine potential structure locations and needs for control measures. The major item of work would be earthfill for the floodwater retarding dams. It is proposed that the principal spillway outlet channel for site 1 be lined with concrete from the dam to the drain. The potential structure would have a reinforced concrete emergency spillway.

Costs for installing the proposed works of improvement were made using reconnaissance level designs for the structural works and current unit prices for the type of material. A twenty percent contingency was added to the construction cost to take care of any unforeseen cost.

The proposed structures will all be located on privately-owned land. The land is all rangeland and no problems are anticipated in acquiring necessary easements and rights-of-way.

Effects and Economic Feasibility of Potential Development

This watershed is adjacent to, and could be considered a part, of Hell's Canyon Watershed; therefore, the land use, crop yields and flooding conditions are very similar to Hell's Canyon Watershed.

Agricultural and urban flood damages were adapted from Hell's Canyon Watershed and applied on a unit basis to this watershed. There are approximately 150 houses and 3,100 acres of agricultural land subject to flooding.

Damaging floods are expected to begin with the 2-year frequency event. Without flood protection, agricultural damages are estimated to be $46,000 and urban damages $54,800 annually. Indirect damage associated with the flood hazard is expected to be about $10,000 annually. After the installation of potential project measures, these damages are expected to be reduced by about 90 percent. This reduction would yield about $99,700 in average annual benefits (table 5). In addition to these benefits, redevelopment benefits are estimated to be $17,500 and secondary benefits $9,500. Average annual project benefits are estimated to be $126,700 (table 7).

The average annual cost of structural measures including operation and maintenance amounts to $87,450. A benefit-cost ratio of 1.4 to 1 is derived by comparing total project benefits to the average annual cost of structural measures.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems would be the ultimate decrease in downstream damages and reduction in capacity requirements for flood control. The land treatment measures should also contribute to improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are $190,000. The average annual returns are estimated to be $657,800.

Alternatives and Other Possibilities

There are potential structure sites above the locations shown in this report, but moving upstream would decrease the protection afforded. A channel from each structure to the river is a possibility; however, due to the necessity of installation of a road crossing, several ditch and channel crossings and the channels passing through high-value cropland, this possibility is not considered feasible nor practical.

Table 1, Structure data, Canyon Sales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. Vol. of fill (cu.yd.)	Principal spillway Type	Principal spillway Release rate (csm)	Emergency spillway Type	Emergency spillway % chance of use	Max. surf. area em. spill. level (acres)	Structure class
1	74.2	67	475,500	RC conduit	8	RC chute	1.0	260	c
2	5.5	21	396,000	RC conduit	8	RC chute	1.0	69	c
3	10.4	23	396,000	RC conduit	8	RC chute	1.0	130	c

Table 2, Channel data, Canyon Sales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach (100 ft.)	Needed channel capacity (cfs)	Bottom width (ft)	Depth (ft.)	Velocity in channel (ft/sec)	Estimated volume of Excavation (cu.yds.)
Outlet channel for principal spillway						
discharge #100	54	594	6	5.0	16	conc. lined
#200	5	44	10	1.5	3	600
#300	5	83	20	1.5	3	1,000

Table 3, Reservoir storage capacity, Canyon Sales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Storage capacity planned: Sediment	Detention	Total
	(sq.mi.)	- - - - - - acre feet	- - - - -	- - - - -
1	74.2	419	5,140	5,559
2	5.5	41	450	491
3	10.4	75	860	935

Table 4, Distribution of structural cost-potential development (dollars) 1/

Structural measures		Installation cost: Construction	Installation services	Land, easements & RW 2/	Administration of contracts	Installation cost
Floodwater retarding structure						
	Site 1	500,000	215,000	2,500	500	718,000
	Site 2	258,000	111,000	5,500	500	375,000
	Site 3	262,000	113,000	5,500	500	381,000
Principal spillway outlet channels	#100	63,000	30,000	10,500	500	104,000
	#200	28,000	18,000	36,500	1,500	84,000
	#300	5,000	4,000	7,500	500	17,000
Total		1,116,000	491,000	68,000	4,000	1,679,000

1/ Price base 1969
2/ Includes costs for structures not cost shared under PL 566

Table 5, Estimated average annual flood damage reduction benefits, Canyon Sales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater			
Agricultural	46,000	4,600	41,400
Urban	54,800	5,500	49,300
Indirect	10,000	1,000	9,000
Total	110,800	11,100	99,700

1/ Based on adjusted normalized prices

Table 6, Annual cost

Evaluation Unit	Amortization of install. cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
Floodwater retarding structures 1, 2, 3, and channel improvements	82,550	4,900	87,450

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Redevelopment	Secondary	Total	Ave. ann cost	Benefit cost ratio
Floodwater retarding structures 1, 2, 3, and channel improvements	99,700	17,500	9,500	126,700	87,450	1.4:1

1/ Adjusted normalized prices

LEGEND

②	FLOODWATER RETARD STRUCTURE SITE NUMBER
1c	GRASSLAND MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3a	SAGEBRUSH MGT.
5b	BOTTOMLAND MGT.
6a	IRRIGATED LAND
7	MISCELLANEOUS LAND
	PAVED HIGHWAY.
	SECONDARY ROADS
	UNIMPROVED ROADS
	RAILROAD
	HOUSE
	TOWN
	COUNTY BOUNDARY
	DRAINAGE PATTERN

Scale

2 1 0 1 2 3 4 Miles

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

CANYON SALES WATERSHED
UPPER RIO GRANDE BASIN

P I N O   D R A W   W A T E R S H E D

Socorro County, New Mexico
CNI #1-104

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located in the northeastern part of Socorro County about 27 miles north of Socorro. It extends from U. S. Highway 60 north along the Rio Grande for about 8 miles. The north boundary extends along the divide south of Abo Arroyo. The watershed boundary to the east is along the crest of the Los Pinos Mountains. For more detailed information on the watershed see the attached map.

State Highway 47 traverses the watershed from north to south and U. S. Highway 60 from east to west. The communities of Las Nutrias and Veguita are within the watershed. The watershed includes an area of about 83,456 acres or 130.4 square miles and the drainage pattern is generally to the west. The bottomland area along the Rio Grande is primarily irrigated cropland. As this land was developed, the arroyos were leveled and consequently have no channels to the river but, instead, drain into the main irrigation canal.

All the land in the watershed is privately owned.

There are approximately 3,300 acres of irrigated cropland, 9,000 acres of woodland, 2,500 acres of bottomland vegetation, and 68,650 acres of grassland.

Sea level elevations range from 4800 feet where the Rio Grande passes under U. S. Highway 60 to 6400 feet at the crest of the Los Pinos Mountains.

The watershed is in the Southern Desertic Basins Plains and Mountains Land Resource Area. It is included in the Mexican Highland Section of the Basin and Range Physiographic Province.

The average annual temperature at Belen is 57° F. with a high of 97° F. and a low of -7° F. The average annual rainfall is 7 inches at Belen. Evaporation rates are high.

The watershed is within the Four-Corners Economic Development Region.

Watershed Problems and Needs

Since the arroyos have no outlets to the river, they overflow the canal into which they empty flooding the irrigated farmland below. Some flood damages were reported every year by the local people. On the average of every three years about 1,000 acres of land are damaged to the extent that crops are lost and the land has to be releveled.

Floodwaters heavily laden with sediments flow into the canals, filling them with sediments. Extensive damage to about 5,600 acres of crops located downstream from the watershed ensues due to lack of irrigation water. This includes some irrigated land outside of the watershed.

Several homes are damaged by floodwater in the communities of Las Nutrias and Veguita annually. Highways and bridges are damaged annually and a three or four mile section of State Highway 47 must be cleaned each time the arroyos flood.

The three-year frequency flood causes an estimated damage of $85,000. A flood caused by a storm equal to the 100-year frequency event would cause damages estimated to be $230,000.

Flood area near Griego Brothers Ranch Headquarters. This is below proposed Site 3

SCS PHOTO 12-P1001-11

Approximately 13 percent of the watershed has critical erosion problems. In some areas, erosion rates are as high as 3 acre-feet per square mile per year.

This area is in need of land treatment and flood prevention measures to reduce the floodwater and sediment damage to residences, businesses, highways, canals, crops, and cropland. There are needs for irrigation system reorganization and improvement as well as installing on-farm ditch and water control structures.

Physical Potential for Meeting Needs

Water-based recreation is not considered feasible due to the low average annual precipitation, high evaporation rate, and the absence of suitable structure locations.

Land treatment measures could be installed on rangeland which would encourage better cover conditions. Cropland can be treated with measures which will improve irrigation water management and enhance the productivity of the land. Due to the climate and soils the land treatment cannot meet the flood prevention need without the installation of floodwater retarding structures to control the runoff.

The topography is nearly level north to south, and fairly steep east to west. This topographic condition does not lend itself to the installation of floodwater retarding structures but, due to the high cost of channelization, it is felt that retarding structures would be the best method of flood prevention.

Borrow material at all potential structure sites is rated as fair for use in earthfill construction. Surface investigations of the foundations and abutments were made at each structure location. The sites are located in the geologic strata of the Santa Fe Group of geologic strata which consists of Quaternary age alluvium and terrace deposits and will present no problems of installation or maintenance of the structures. Before construction, detailed permeability investigations of abutments should be made.

There are no existing channels to outlet floodwater to the river; therefore, outlet channels for the floodwater retarding structures must be installed. The most logical alternative is to utilize the existing irrigation and drainage systems and accomplish two purposes: (1) agricultural water management, and (2) flood prevention. This can be done by installing a concrete-lined outlet channel from each structure to the canal. This channel would be designed to carry the floodwater to a point where it can flow into the drain and on to the Rio Grande.

Local Interest in Project Development

The individuals contacted during the field investigation were aware of the flood hazard within this watershed. They are interested in finding ways to control the floodwater from the arroyos. The people are also aware of the need for agricultural water management. Much of the land is leveled and some concrete-lined irrigation ditches have been installed. The conservation program is very active in this area. With flood protection, the conservation program could proceed more rapidly. There is no legal organization for sponsoring a project, but the local people feel that obtaining financial support and legal sponsorship for a watershed project would present no problems.

It is recommended that the district conservationist and soil and water conservation district work with those people, and that a legal sponsoring organization be formed or existing organizations such as the county commission be approached for sponsorship of such a program.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Good range management on 36,864 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities. Along Highway 47 between Las Nutrias and Highway 60 are small areas of mesquite and sand sage. At the present time, the plants are providing protection for the soil from wind erosion. As management becomes better and grass density increases, this brush can be removed.

(b) Phreatophyte control on 922 acres of bottomland.

(c) Effective drainage systems on 100 acres of crop, pasture, and hayland.

(d) Improved irrigation facilities on 1,664 acres of irrigated land.

(e) Erosion control on 9,796 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in areas

of heavy use near farmsteads and urban areas. Effective methods that may be used on land subject to critical erosion are small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

Structural Measures

To provide the level of flood protection that is desirable for the area being damaged, floodwater retarding structures with related outlet channels appear to afford the best solution. The potential structural works would be five floodwater retarding structures with a required capacity for sediment and floodwater of about 10,000 acre feet. A lined channel from each structure to the Las Nutrias Lateral is proposed for sites 1 to 4 to discharge the flow from each principal spillway. The canal would have to be enlarged to handle the additional water from flood flows. This increased flow would be released to the Las Nutrias drain and to the Rio Grande near site 5. The principal spillway flow from site 5 would be carried by lined channel directly to the drain and discharged into the river. The storage structures are planned as single-purpose flood prevention structures.

Nature and Estimate of Costs of Improvements

Investigation of the watershed was made at a reconnaissance level. A field reconnaissance was made using aerial photos and 1:24,000 U. S. Geological Survey quad maps. Potential structure sites were checked on site and on the quad sheets. Potential structure location on the quad sheets was used to estimate structure capacity and the required earth embankment. Items of work will be earth embankment for five floodwater retarding structures, reinforced concrete chute emergency spillways at all five structures, earthwork for cleaning and enlarging the drain and irrigation lateral, and constructing a channel to the river from the drain. Concrete-lined channels are proposed as principal spillway discharge channels.

The estimated cost of construction and installation services was made by applying a unit cost to the estimated embankment volume. This unit cost value was taken from curves developed from detailed data prepared for Public Law 566 projects in New Mexico. Other estimated costs are based on preliminary design for quantities from map data and applying current unit cost values to these quantities. Twenty percent of construction cost was added for contingencies.

Effects and Economic Feasibility of Potential Development

The proposed structural measures would provide a high degree of flood protection to approximately 3,300 acres of irrigated land, about 30 farm homes and rural residences, and to State Highway 47. Floodwater damages evaluated under present conditions amount to $171,800. This includes indirect damages. After project measures are installed, the estimated average annual damages will be reduced to $10,600. This is approximately 94 percent reduction in damages.

Redevelopment-type benefits accruing to local labor which will be used in project construction, operation and maintenance amount to $28,500. In addition to these benefits, secondary benefits in the amount of $15,600 will accrue to a variety of sources.

Average annual project benefits evaluated amount to $205,300 and the average annual cost of structural measures is estimated to be $137,230. When average annual benefits are compared to average annual costs a benefit-cost ratio of 1.5 to 1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $78,100. The average annual returns are estimated to be $224,600.

This watershed project will help alleviate air and water pollution and in doing so will enhance the environment.

Alternatives and Additional Possibilities

This report includes data about structural measures which are considered feasible at this time. There are alternate site locations, but there would be a loss of control and feasibility would be questionable. One possibility is to construct a channel from each structure to the Rio Grande; however, due to the cost of installing the necessary road crossings, ditch crossings, and because of the large amount of high-value cropland involved, this possibility is not considered feasible or practical.

Table 1, Structure data, Pino Draw Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway Type	Principal spillway Release rate	Emergency spillway Type	Emergency spillway % chance of use	Max. surf. area em. spwy. level	Struc. class
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	0.9	18	140,400	RC conduit	8	RC chute	1	20	c
2	3.4	40	140,000	RC conduit	9	RC chute	1	40	c
3	3.0	15	124,700	RC conduit	8	RC chute	1	46	c
4	15.6	44	216,000	RC conduit	8	RC chute	1	105	c
5	92.0	55	1,471,500	RC conduit	8	RC chute	1	320	c

Table 2, Channel data

Channel designation	Length of reach	Watershed area	Needed channel capacity	Bottom width	Depth	Velocity in channel	Estimated volume of excavation
	(100 ft.)		(cfs)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
100	28	0.9	10	1	1.5	5.0	conc. lined
200	10	3.4	30	1.5	2.6	4.5	" "
300	15	3.0	24	1.5	2.0	9.0	" "
400	26	15.6	128	4.0	2.8	11.5	" "
500	35	92.0	734	6.0	5.4	17.4	" "
Main 1/	250	--	200	15	4.0	3.5	--

1/ Enlarged canal to carry principal spillway discharge from site 2, 3, and 4

Table 3, Reservoir storage capacity, Pino Draw Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Storage capacity planned		
		Sediment	Detention	Total
	(sq.mi.)	- - - - - - - - acre feet - - - - - - - - -		
1	0.9	180	80	260
2	3.4	152	300	452
3	3.0	157	300	457
4	15.6	129	1290	1419
5	92.0	600	6800	7400

Table 4, Distribution of structural cost - potential development (dollars) 1/

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Floodwater retarding					
structures Site 1	130,000	56,000	3,500	500	190,000
Site 2	152,000	65,000	1,500	500	219,000
Site 3	118,000	51,000	1,500	500	171,000
Site 4	215,000	92,000	1,500	500	309,000
Site 5	1,000,000	430,000	1,500	500	1,432,000
Channel 100	8,000	4,000	4,000 2/	1,000	17,000
200	3,000	2,000	2,500 2/	500	8,000
300	6,000	2,000	2,600 2/	500	11,000
400	21,000	9,000	6,500 2/	500	37,000
500	77,000	30,000	13,500 2/	500	121,000
Main 3/	72,000	26,000	1,500	500	100,000
Totals	1,802,000	767,000	40,100	6,000	2,615,000

1/ Price base: 1969
2/ Includes road crossing costs
3/ Enlarged canal to carry principal spillway discharge from sites 2, 3, and 4.

Table 5, Estimated average annual flood damage reduction benefits, Pino Draw Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Floodwater			
Cropland and urban	156,200	9,020	147,180
Indirect	15,600	1,580	14,020
Total	171,800	10,600	161,200

1/ Based on adjusted normalized prices

Table 6, Annual cost

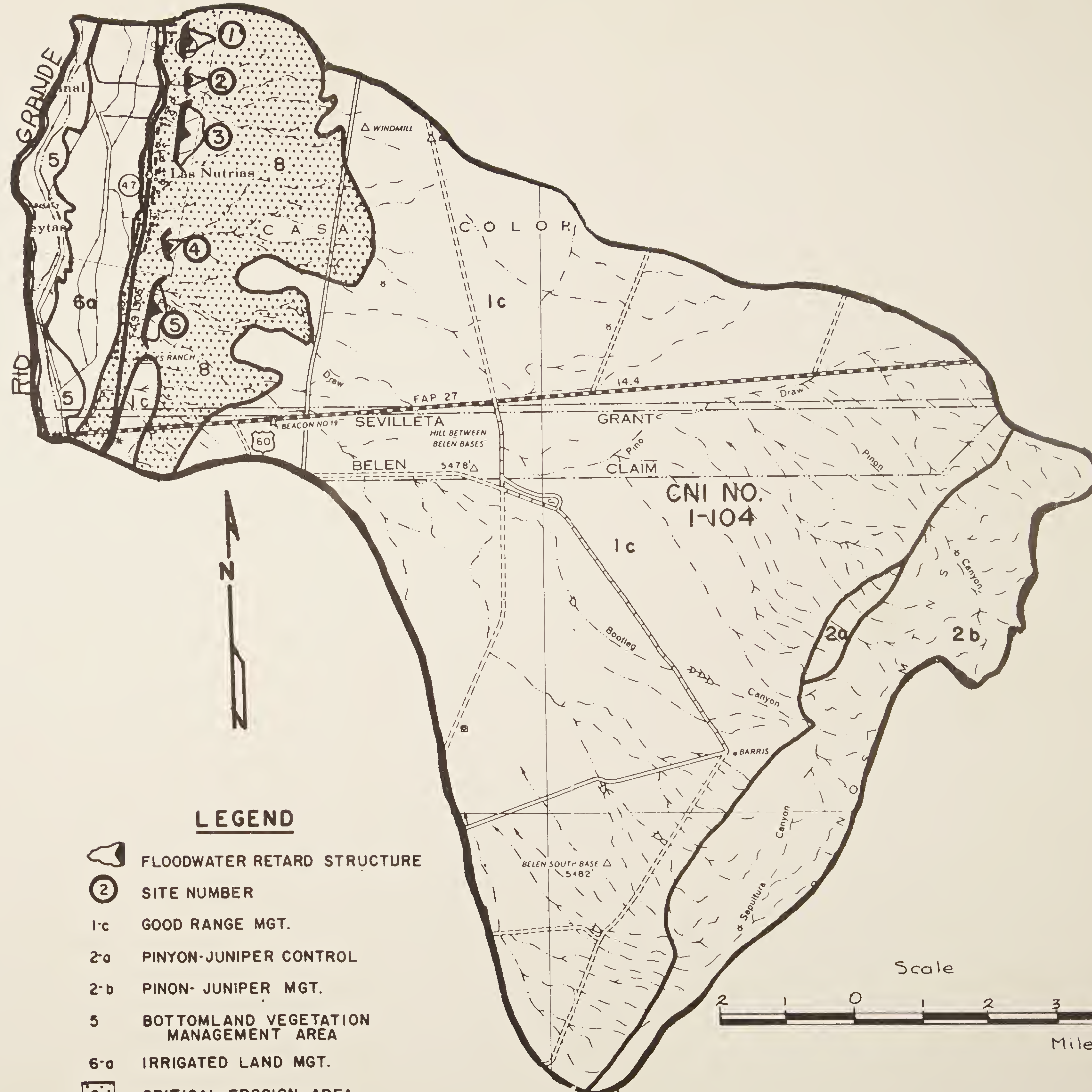
Evaluation unit	Amortization of installation cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
FRS 1, 2, & 3	30,290	1,900	32,190
FRS 4 & 5	98,290	6,750	105,040
Total	128,580	8,650	137,230

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Based on adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures, (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Redevelopment	Secondary	Total	Average annual cost	Benefit cost ratio
FRS 1, 2, & 3	19,500	6,600	2,000	28,100	32,190	0.9:1
FRS 4 & 5	141,700	21,900	13,600	177,200	105,040	1.7:1
Total	161,200	28,500	15,600	205,300	137,230	1.5:1

1/ Adjusted normalized prices



STRUCTURE LOCATION
AND
LAND TREATMENT MAP
PINO DRAW WATERSHED
UPPER RIO GRANDE BASIN

L E M I T A R - P O L V A D E R A   A R R O Y O S   W A T E R S H E D

Socorro County, New Mexico
CNI #1-99

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The Lemitar-Polvadera Watershed is about four miles north of Socorro on the west side of the Rio Grande. The watershed begins at Nogal Arroyo and extends north for approximately 7 1/2 miles to San Lorenzo Arroyo. The arroyos included within the watershed flow from the Lemitar Mountains eastward to the Rio Grande flood plain. These arroyos originally had channels to the river, but in recent years, the bottomland has been leveled and developed into highly productive irrigated cropland. In the process of leveling the land, the arroyo channels were also leveled and there are no channels to the river.

The watershed contains a total of 32,192 acres (50.3 square miles) of which 1,860 acres are state-owned lands, 18,040 acres are federal lands administered by the Bureau of Land Management, and 12,292 acres are privately-owned lands. The villages of Lemitar and Polvadera are situated within the watershed.

The Lemitar Mountains are composed primarily of the rhyolite facies of the Datil formation. Several faults within the mountains have exposed Pre-Cambrian rocks and the Madera limestone of Pennsylvanian age.

Between the mountains and Highway 85, the area is underlain by Santa Fe geologic group strata of Tertiary age. The Santa Fe geologic group consists of sand, silt, and clay, generally unconsolidated to loosely consolidated.

The two largest of the arroyos are entrenched in the pediment surface which comprises the intermediate area between the mountains and the Rio Grande floodplain. Numerous other arroyos flow down the steep slopes without having cut vertical walled canyons. The average slope from the mountains to Highway 85 is approximately 260 feet per mile.

Soils of the upland area are of sandy texture, shallow, and generally rocky. Soils of the mountain slopes are either very shallow or entirely absent, with a considerable area of bare rock exposed. The pediment surface and the terraces along the principal arroyos are covered with a veneer of desert pavement. Soils of the Rio Grande floodplain are generally deep and have loamy or clayey profiles.

The steep slopes are subject to sheet and gully erosion. A veneer of desert pavement aids in reducing erosion.

Average annual precipitation ranges from about 7 inches in the valley to about 11 inches in the higher elevations.

The greatest amount of precipitation occurs during July, August, September, and October. The area receives some snowfall during the winter months but it is generally light and melts rapidly.

Floods are produced by high-intensity, short duration thunderstorms. The high-intensity rains, sparse vegetative cover, and steep slopes combine to produce a high degree of runoff.

Mean sea level elevations in the watershed range from 4620 feet at the Rio Grande to 7290 feet at the top of Polvadera peak.

The average annual temperature is about 58.4° F. The extreme temperatures on record are 108° F. and 16° F. below zero.

About 75 percent of the floodplain of the Rio Grande is devoted to irrigated cropland. Crops consist of cotton, alfalfa, small grains, and corn. There is some vegetable production and a few small garden tracts. There is one small cultivated area west of the highway irrigated with well water.

Irrigation water is obtained from the Rio Grande and is supplied through the canal systems of the Middle Rio Grande Conservancy District. This organization also supplies drainage protection. The district is a legal division of the state and is operated in cooperation with the U. S. Bureau of Reclamation. The San Acacia Diversion Dam diverts water from the Rio Grande into the Socorro Main Canal which supplies water to irrigated land in the vicinity of Socorro and San Antonio. The Socorro Main Canal furnishes water to lands south from San Acacia for about 29 miles. All of the arroyos which flow to the east would have some effect on the water delivery system.A few of the irrigated tracts have irrigation wells for supplemental irrigation. Water for household use is obtained from shallow wells.

All of the land outside of the Rio Grande floodplain is classified as grazing land. The vegetation is sparse, consisting predominantly of creosote bush with some annual weeds. Carrying capacity is low. Near the mountains there is a slight increase in vegetation. Creosote bush, prickly pear, yucca, and mesquite are the brush varieties common to the watershed. At the base of the mountains, clumps of bush muhly, threeawn and dropseed occur. This area is sparsely grazed due to the lack of stock water.

Socorro County is within the Four-Corners Redevelopment Area.

Watershed Problems and Needs

The valuable irrigated farmlands of the watershed are damaged nearly every year by floodwater from one or more of the arroyos. These damages include loss of crops by inundation and deposition of sediment, loss of productivity

Upstream side of culvert under U. S. Interstate 25 below proposed site 4
SCS PHOTO 12-P991-16

Same culvert on downstream side of Interstate 25
SCS PHOTO 12-P1001-1

due to interruption of irrigation water, loss of land due to deposition of coarse sediment, and damage to irrigation facilities.

All of the arroyos terminate against the Lemitar-Polvadera canal. The canal banks offer some protection to the lands situated east of the canal. Sediment damage to the canal causes high annual maintenance costs. Sediment-laden floodwater flows into the irrigation canals and laterals filling them with sediment and causing them to break eventually flooding the land below.

Other damage occurs to homes, stores, roads, and public utilities, particularly in the vicinity of the village of Lemitar. The Santa Fe railroad which traverses the area from north to south, also suffers some damage.

The canals and ditches are to a large extent constructed of earth, and in some localities seepage from the canals is a problem. In the future, canal and ditch lining will probably be needed. In the later summer, irrigation water is in short supply.

It is estimated that the 1963 storm which is about a 20 percent chance storm, caused damages amounting to $70,000 in the watershed. It is estimated that the 100-year frequency storm would cause $235,000 of damage to highway, residences, businesses, irrigation facilities, crops and cropland.

All the native grazing land in the watershed is subject to severe erosion. Special methods are needed to restore its productive capacity. About 10 percent of the soils have a salt and alkali problem that limits crop varieties and reduces yields. The grassland and brushland also present problems. There is a lack of livestock water, so grazing during the past few years has been relatively light. Bureau of Land Management has applied limited grazing use on all land administered by them.

Physical Potential for Meeting Needs

The topography, soils and geology of the watershed are favorable for installation of the potential structures. Adequate sites for potential structures are available.

In general, irrigated land has been provided with adequately maintained drainage facilities. Irrigation canals and laterals are well maintained. Lining of the canals would decrease seepage losses and make more water available during the time when water is low in the Rio Grande.

About 15 percent of the brushland has a soil slope combination on which brush could be removed. While this is not a popular practice, these deeper soils on moderate slopes could be cleared and reseeded to grass.

There is a possibility that the upper half of the watershed could be used for recreation purposes because of its proximity to Socorro. Presently it supports a limited population of mourning dove, quail, and deer. It has

Arroyo heading east toward village of Lemitar SCS PHOTO 12-P1001-3

Same arroyo terminating in irrigation canal. Note sediment on fields below canal where canal bank has broken allowing sand and gravel to damage cropland. SCS PHOTO 12-P1001-5

limited potential for antelope. Development of watering places and vegetative cover could increase wildlife population.

Local Interest in Project Development

An application for a Public Law 566 flood prevention project was submitted in June 1958. Authorization for planning was given in October 1959, and the first draft of the work plan was issued in February 1961. Planning was terminated September 1961 because a sponsor with legal means to assess levies and acquire rights-of-way was unavailable.

In 1968 an interest and concern for flood problems in this area were revived. Local residents and the Socorro Soil and Water Conservation District felt that the plan should be reviewed and that adequate sponsorship could be achieved, a point that will be pursued immediately. Representatives for federal land foresee no problems in complete cooperation with local people.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Good management of 3,222 acres of critically eroded land.

(b) Creosote brush control on 3,135 acres of brushland.

(c) Phreatophyte control on 225 acres of land.

(d) Effective drainage on 370 acres of salt or alkali affected land.

(e) Improved irrigation systems on 2,269 acres of irrigated land.

Structural Measures

This study has shown that four potential floodwater retarding structures and two floodwater diversions are feasible. The topography is far from ideal for dam installation but long dams can be installed and necessary storage can be obtained. As a result of topographical factors, it was decided that two floodwater diversions could be installed at less cost than retarding structures.

Channels to convey the principal spillway discharges to the river will have to be installed. It is proposed that channels from Sites 2A, 3A, and 4 be concrete-lined to the Lemitar-Polvadera irrigation lateral and from there, the combined flow be conveyed in the canal to a point at which it can be outletted to the river.

Nature and Estimate of Costs of Improvements

Structure data available from the study made in 1961 was used to determine storage, volumes, and estimated heights of the structures.

From the structure data developed, a unit cost for earthwork in high-hazard dams was used to determine the total construction and installation services for the structures. To determine the cost of outlet channel structures, the 1961 estimated cost was adjusted to 1969 prices.

The principal items of construction will be the earthfill dams with reinforced concrete chute emergency spillways and the earthen floodwater diversions.

The entire area in and around the structure sites is pasture land in poor condition. No problems are anticipated in obtaining easements and land rights.

Effects and Feasibility of Potential Development

The installation of the proposed structural measures will provide a high degree of protection from flood damage to about 3,000 acres of irrigated land and the irrigation systems which serve the land and protect approximately 80 rural residences and a small number of business establishments in Polvadera.

The estimated average annual floodwater and sediment damage to crops, pasture, other agricultural facilities, and roads and bridges amounts to about $58,400 based on adjusted normalized prices. Average annual urban damages within this watershed amount to about $44,800. Agricultural and urban damages, including indirect, combined make a total of $103,200. After project measures are installed, these damages would be reduced to $17,700 or a damage reduction of about 83 percent.

The value of local secondary benefits accruing to the project would amount to $14,460 annually. They would accrue as a result of increased net income to producers and processors of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project.

Redevelopment benefits associated with watershed project measures are estimated to be $21,320 annually. They would accrue to presently unemployed labor which would be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

Average annual benefits are estimated at $121,280 and average annual costs estimated to be $102,280. The benefit-cost ratio is 1.2 to 1.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction incapacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $90,800. The average annual returns are estimated to be $337,200.

Alternate or Additional Possibilities

From on-site and map investigation, it appears that the flow into Site 3A can be diverted into Site 2A. This possibility needs more detailed investigation to determine physical conditions. If this is practical, the cost of increasing the capacity of Site 2A should be less than the cost for the structure on Site 3A.

Irrigation water management should also be investigated and included in a detailed and comprehensive plan for development and flood control. This would include lining of irrigation canals as a group project.

Table 1, Structure data, Lemitar-Polvadera Arroyos Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway: Type	Principal spillway: Release rate	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surf. area em. spwy. level	Structure class
	(sq.mi.)	(feet)	(cu.yds.)		(csm)			(acres)	
2A	7.5	37	183,522	RC conduit	10	RC chute	1	85	c
3A	9.7	65	245,625	RC conduit	10	RC chute	1	37	c
4	7.5	50	814,270	RC conduit	10	RC chute	1	117	c
5	7.9	43	410,602	RC conduit	10	RC chute	1	60	c

Table 2, Reservoir storage capacity

Site number	Drainage area	Storage capacity planned: Sediment	Storage capacity planned: Detention	Storage capacity planned: Total
	(sq.mi.)	- - - -acre- feet - - - - - -		
2A	7.5	208	732	940
3A	9.7	264	946	1210
4	7.5	321	729	1050
5	7.9	356	519	875

Table 3, Channel data, Lemitar-Polvadera Arroyos Watershed, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach	Watershed area	Needed channel capacity	Bottom width	Depth	Velocity in channel	Estimated volume of excavation
	(100 ft.)	(sq.mi.)	(cfs.)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
Floodwater diversion 301	15	9.1	3,800	290	3.2	3.9	24,000
Floodwater diversion 401	66	2.8	1,800	200	2.2	4.0	122,200
Floodwater diversion 501	80	3.9	2,000	200	2.5	4.0	148,000

Table 4, Distribution of structural cost-potential development, Lemitar-Polvadera Arroyos Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost: Construction	Installation cost: Installation services	Installation cost: Land, easements and RW	Installation cost: Administration of contracts	Installation cost: Installation cost
Evaluation unit 1					
Site 2A-Canada Ancha	231,000	99,000	2,500	500	333,000
Riprap irrigation ditch	3,000	1,000	--	---	4,000
Site 3A-Puertocito Canyon	267,000	114,000	2,500	500	384,000
Floodwater diversion 301	42,000	18,000	1,000	---	61,000
Outlet channel w/str.	10,000	5,000	--	---	15,000
Riprap irrigation ditch	2,000	1,000	--	---	3,000
Site 4-Chupadera Arroyo	371,000	159,000	1,500	500	532,000
Outlet channel w/str.	21,000	9,000	--	---	30,000
Riprap irrigation ditch	1,000	1,000	--	---	2,000
Floodwater diversion 401	43,000	18,000	1,500	500	63,000
Total evaluation unit 1	991,000	425,000	9,000	2,000	1,427,000
Evaluation unit 2					
Site 5-Polvadera Arroyo	281,000	121,000	2,500	500	405,000
Outlet channel w/str.	30,000	16,000	--	---	46,000
Floodwater diversion 501	52,000	22,000	1,500	500	76,000
Total evaluation unit 2	363,000	159,000	4,000	1,000	527,000
TOTAL	1,354,000	584,000	13,000	3,000	1,954,000

1/ Price base: 1969

Table 5, Estimated average annual flood damage reduction benefits, Lemitar-Polvadera Arroyos Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Est. average annual damage: Without project	Est. average annual damage: With project	Damage reduction benefits
Floodwater			
Crop and pasture	22,300	4,400	17,900
Interrupted irrigation service	26,100	5,000	21,100
Urban	44,800	6,400	38,400
Subtotal	93,200	15,800	77,400
Sediment	1,700	300	1,400
Indirect	8,300	1,600	6,700
Total	103,200	17,700	85,500

1/ Based on adjusted normalized prices

Table 6, Annual cost

Evaluation unit	Amortization of installation cost (dollars) 1/	Operation & Maintenance cost (dollars) 2/	Total annual cost
Unit 1			
FRS 2A, 3A, 4 and appurtenances	70,170	4,800	74,970
Unit 2			
FRS 5 and appurtenances	25,910	1,400	27,310
Total	96,080	6,200	102,280

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefit: Damage red.: flood prev.	Redevelopment	Secondary	Total	Average annual cost	Benefit cost ratio
Unit 1						
FRS 2A, 3A, 4, and appurt.	71,000	15,660	11,000	97,660	74,970	1.3:1
Unit 2						
FRS 5 and appurt.	14,500	5,660	3,460	23,620	27,310	0.9:1
Total	85,500	21,320	14,460	121,280	102,280	1.2:1

1/ Adjusted normalized prices

LEGEND

- DRAINAGE PATTERN
- HOUSE
- BRIDGE
- RAILROAD
- FLOODWATER RETARD STRUCTURE
- FLOODWATER DIVERSION
- OUTLET CHANNEL
- BENEFITED AREA
- IRRIGATION CANALS
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- IRRIGATED LAND-NO TREATMENT REQUIRED
- LOW WATER CHANNEL-M.R.G.C.D. (AREA EAST OF THIS CHANNEL IS NO LONGER IN WATERSHED TREATMENT AREA. THIS AREA IS BEING MAINTAINED FREE OF PHREATOPHYTE BY CONSERVANCY DISTRICT).
- 2b PINYON-JUNIPER MGT.
- 3a3 CREOSOTE BRUSH CONTROL
- 3b3 CREOSOTE BRUSH MGT.
- 5a BOTTOMLAND VEGETATION CONTROL
- 6a IRRIGATED LAND MGT.
- 7 MISCELLANEOUS LAND
- 8 CRITICAL EROSION AREA
- DIVIDED HIGHWAY
- PAVED HIGHWAY
- SECONDARY ROADS

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
LEMITAR-POLVADERA WATERSHED
UPPER RIO GRANDE BASIN

WALNUT CREEK WATERSHED

Socorro County, New Mexico
CNI #1-89

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is in the central part of Socorro County, New Mexico, just south of the city of Socorro. The watershed constitutes 78,490 acres (122.6 square miles). In the watershed there are 52,312 acres of public land of which 4,700 acres are adminstered by the Forest Service and 40,424 acres are administered by the Bureau of Land Management; 13,523 acres are privately-owned land; and 16,249 acres are state land.

The Forest Service land is a portion of the Cibola National Forest and is classed entirely as non-commercial forest.

Vegetation cover and/or land use is as follows: 21,700 acres of grassland, 21,800 acres of woodland, 26,400 acres of brushland, 1,600 acres of bottomland vegetation, and 6,800 acres of irrigated cropland.

The relief pattern is to the east, draining an area on the west slope of the Magdalena Mountains. The east boundary extends about 18 miles south of Socorro along the Rio Grande. Two small communities, Luis Lopez and San Antonio, are within the watershed. Interstate 25 runs north and south through the watershed.

Sea level elevations range from 4600 feet at the Rio Grande to 7200 feet in the Magdalena Mountains. Topography in the area is steep and rough.

Climatic conditions are semi-arid with an average annual precipitation of about 9.6 inches at Socorro and about 25 inches in the mountains. Temperatures range from a high of 108° F. to a low of -25° F. with an average of 58° F. Average frost-free period is 197 days from April 14 to October 28.

Most of the precipitation occurs as rainfall from convective-type summer thunderstorms, usually of high intensity and short duration.

Arroyos in the watershed originally had channels with outlets into the Rio Grande channel. In recent years, however, the flat bottomland along the Rio Grande has been developed into highly productive cropland. As a result of the development, channels were leveled and the arroyos now terminate and empty into the main irrigation canal. Consequently, channels to convey flood flows to the river are non-existent.

The watershed is within the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. The range condition is fair but the hydrologic cover condition over most of the area is poor.

Erosion rates range up to 2.0 acre feet per square mile per year within the watershed. This rate is confined to the Santa Fe Group outcrop area.

Watershed Problems and Needs

Floodwater and sediment cause damages to roads, bridges, residences, irrigation facilities, farm equipment and irrigated cropland. High-intensity short-duration thunderstorms falling on rangeland with poor hydrologic cover conditions and steep topography, concentrate runoff quickly, causing large peak discharges in the arroyos. These conditions make some of the watershed area susceptible to severe erosion.

The floodwaters outlet directly into the main irrigation canal. This fills the canal with sediment causing it to break and inundate irrigated cropland. About 700 acres of cropland and crops are damaged every year from floods. Damages from interrupted irrigation occur on an additional 2,900 acres of land. Major fixed improvements such as farm and ranch homes, small businesses, roads, railroads, and irrigation canals receive considerable damage. County roads are damaged annually from flood flows. At every arroyo crossing the roads are washed out or filled with sediment.

Damage to Santa Fe Railroad right-of-way from Walnut Creek drainage. Track and bridge have been recently raised 18 inches to allow more clearance under the trestle

SCS PHOTO 12-P991-13

Homes and businesses are frequently damaged in the communities of Luis Lopez and San Antonio. The agricultural area flooded by the 100-year frequency storm is estimated to be 3,660 acres. This area is used mainly for the production of alfalfa, corn, irrigated pasture, and a small acreage of vegetables.

Agricultural damages under present conditions are estimated to total $187,000 annually. Average annual flood damages to farm and ranch homes and urban development amount to about $28,340 per year and average annual indirect damage is estimated to be $21,540.

There is need in the watershed for land treatment and other flood prevention measures to control the floodwater and sediment discharged from the arroyos. Grazing management is needed on all areas as about one-half of the rangeland suffers from overuse. Twenty percent of the watershed is producing creosote brush, 3,000 acres of which need to be controlled. Cultivated land comprises nine percent of the watershed of which two hundred twenty acres need drainage and 2,700 acres need improved irrigation systems.

Land treatment measures are needed to increase the vegetative cover, decrease erosion from all sources and increase the amount of on-site water storage. Land treatment on the irrigated cropland is needed to improve water management and lower water tables in some locations. Floodwater retarding structures are needed to supplement the land treatment program to provide the degree of protection needed.

Physical Potential for Meeting Needs

Due to the low average annual precipitation and high evaporation rate, sub-surface water storage for any purpose is not considered feasible. However, there are many locations with potential for developing picnicking and camping on the Rio Grande and in the mountains. There are adequate locations for floodwater retarding structures to control the flooding originating in the watershed.

Sites are located in Quaternary age terrace and alluvial fan deposits which belong to the Santa Fe Group of geologic strata. Abutments will be sand and gravel and cutoff depth in channel at 25 feet or less. Borrow material is adequate although good clay-sand may be difficult to locate. All emergency spillways will be common excavation. Existing outlet channels will probably not scour more than 24 inches.

Because there are no existing channels to the river, outlet channels will have to be installed to convey the principal spillway discharges to the river.

Local Interest in Project Development

The people contacted are aware of the floodwater problem and interested in trying to reduce it. Most of the people are conservation-minded and participate in the installation and application of conservation practices.

At this time, there is no legal organization for the installation, operation and maintenance of a Public Law 566 project. Local people feel that such an organization could be formed if the flood control measures were economically feasible.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Good range management on 17,575 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 768 acres of woodland.

(c) Creosote control on 3,203 acres of brushland.

(d) Phreatophyte control on 1,200 acres of land.

(e) Effective drainage of 220 acres of land.

(f) Improved irrigation facilities on 2,741 acres of irrigated land.

(g) Erosion control on 8,092 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils along the major arroyos east of heavy use near farmsteads and urban areas. Effective methods of erosion control include the use of small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils so grass seeding will produce protective stands of vegetation.

Structural Measures

Potential structural measures needed to supplement land treatment measures and to provide a desired level of protection would consist of floodwater retarding structures with related outlet channels for principal spillway flow.

Walnut Creek Watershed irrigated land SCS PHOTO 12-P991-9

A releveled field after a break in the canal. Larger rocks have been pushed to the fence line. SCS PHOTO 12-P991-5

Damaged areas and structure site conditions are such that 12 floodwater retarding structures would be required to provide this protection. These 12 structures would have an aggregated storage capacity for flood prevention of 9,094 acre feet and would control about 101 square miles of the watershed. The outlet channels for units 1, 3, and 5 would be incorporated with the irrigation canal to a point at which they could be discharged into a large drain with an outlet to the Rio Grande. The other two outlet channels would cross the irrigated land and discharge directly into the drain. The storage structures would be single-purpose flood control measures. The outlet channels would in part serve as agricultural water management measures. The principal spillway discharge from site 12 is expected to discharge into an existing diversion that diverts flood flows to the Bosque del Apache National Wildlife Refuge. This flow would enhance wildlife conditions in the refuge.

Other than channel improvement and concrete canal lining to handle the principal spillway flow, no specific agricultural water management measures are identified and evaluated. Necessary improvements of the irrigation systems in the watershed would have to be a part of the planned development for the Middle Rio Grande Conservancy District. The individual systems and on-farm improvements could be improved on a watershed basis.

Nature and Estimate of Costs of Improvements

The watershed investigation of flood-damage areas and potential structure sites was at a reconnaissance level. Information from U. S. Geological Survey quads (1:24,000 scale) and aerial photos was supplemented by a field reconnaissance of the area.

Estimates of reservoir storage capacities were developed by using the USGS quad sheets. A field survey to obtain a profile of the proposed centerline of each structure was made. These profiles were used to estimate the amount of fill needed in the potential structures.

The major items of work would be earth embankments in 12 proposed dams, one with an emergency spillway of reinforced concrete. Each potential structure would have a reinforced concrete conduit and related works as a principal spillway. The outlet works for the principal spillway discharge would consist of culverts under a state highway and under the Santa Fe Railroad. Part of the channels are designed with concrete lining and would carry flows varying from 50 to 262 cubic feet per second.

The cost estimate for construction and installation of the dams was made by applying a unit cost to the estimated embankment volume.

This unit cost was obtained from a curve developed from detailed plans and costs for structures in PL 566 work plans for areas similar to this watershed. Other cost items are based on preliminary designs and quantities from map data. The unit costs are from current values and estimates made from the field reconnaissance.

Land easements and rights-of-way are not considered to be a problem; however, there are several items that would be expensive to move. Site 2 would flood an existing gravel operation and two of the sites would flood stock water wells. One site has 2 miles of ranch road that would have to be rerouted. Another site has an underground telephone cable near the dam axis that would have to be moved.

Effects and Economic Feasibility of Potential Development

The installation of the proposed structural measures would provide a high degree of protection from flood damage to about 3,500 acres of irrigated land and the associated irrigation systems, protecting about 60 residences and business properties in the community of San Antonio.

After the installation of potential structural measures, agricultural damages would be reduced to approximately $7,980 per year. This is a 95 percent reduction in damage, and it produces damage reduction benefits in the amount of $179,200 per year. Residential damages would be practically eliminated after installation of the project. Indirect damages associated with the flooded conditions amount to $21,540 per year. The installation of the project would result in a 96 percent reduction in these damages and would produce about $20,740 in average annual benefits.

The average annual cost of all structural measures including operation and maintenance is estimated to be $217,810, and total average annual benefits are estimated to be $295,840. A benefit-cost ratio of 1.4 to 1 is derived by comparing annual benefits to annual cost.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

The average annual costs for the land treatment systems are estimated to be $76,500. The average annual returns are estimated to be $333,700.

Alternate or Additional Possibilities

Near the southwest corner of the watershed is Torreon Spring, an oasis consisting of a small lake surrounded by trees. The Bureau of Land Management has developed plans for a recreation area, part of which will be in this watershed. At the present time Torreon Spring is under private ownership and the owner is not in favor of this plan.

Table 1, Structure data, Walnut Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. vol. of fill (cu.yd.)	Principal spillway: Type	Principal spillway: Release rate (csm)	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surf. area em. spwy. level (acres)	Structure class
1	1.8	36	68,500	RC conduit	8	RC chute	1	17	c
2	1.9	33	150,200	RC conduit	8	RC chute	1	30	c
3	2.3	43	104,800	RC conduit	8	RC chute	1	22	c
4	30.4	61	533,100	RC conduit	8	RC chute	1	112	c
5	1.7	49	194,200	RC conduit	8	RC chute	1	14	c
6	10.5	58	285,200	RC conduit	8	RC chute	1	45	c
8	32.8	68	499,100	RC conduit	8	RC chute	1	105	c
9	1.7	50	207,500	RC conduit	8	RC chute	1	22	c
10	2.5	31	134,300	RC conduit	8	RC chute	1	36	c
11	3.7	40	249,300	RC conduit	8	RC chute	1	32	c
12	8.4	52	306,900	RC conduit	8	RC chute	1	40	c
13	3.1	38	117,100	RC conduit	8	RC chute	1	32	c

Table 2, Channel Data, Walnut Creek Watershed, Upper Rio Grande Basin

Channel designation	Length of reach (100 ft.)	Watershed area (sq.mi.)	Needed channel capacity (cfs)	Bottom width (ft.)	Depth (ft.)	Velocity in channel (ft./sec.)	Estimated volume of excavation (cu.yds.)
Unit #1	87.5	5.0	50	3.0	3.0	4	conc. lined
Unit #2	27.0	30.4	243	20.0	5.0	3	14,450
Unit #3	63.0	12.2	100	4.0	5.0	4	conc. lined
Unit #4	40.0	32.8	262	4.0	5.0	7.3	conc. lined
Unit #5	124.0	11.0	110	3.0	4.0	5.4	conc. lined

Table 3, Reservoir Storage Capacity, Walnut Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Sediment	Detention	Total
	(sq.mi.)	- - - - - - - -	-acre-feet	- - - - -
1	1.8	97	170	267
2	1.9	98	170	268
3	2.3	116	220	336
4	30.4	284	2150	2434
5	1.7	88	170	258
6	10.5	192	760	952
8	32.8	172	2320	2492
9	1.7	89	200	289
10	2.5	83	230	313
11	3.7	93	370	463
12	8.4	115	560	675
13	3.1	77	270	347
Total	100.8	1504	7590	9094

Table 4. Distribution of Structural Cost - Potential Development, Walnut Creek Watershed, El Rio en Medio Subbasin, Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost: Construction	Installation services	Land, easements and r. w.	Administration of contracts	Installation cost
Evaluation unit no. 1					
Site 1	82,000	34,500	1,000	500	118,000
Site 2	120,000	52,000	25,500	500	198,000
Site 3	113,000	48,500	1,000	500	163,000
Site 4	480,000	160,000	1,500	500	642,000
Channel Improvement	114,000	49,000	10,000	1,000	174,000
Subtotal	909,000	344,000	39,000	3,000	1,295,000
Evaluation unit no. 2					
Site 5	162,000	70,000	1,500	500	234,000
Site 6	257,000	111,000	10,500	500	379,000
Channel Improvement	54,000	23,000	5,000	1,000	83,000
Subtotal	473,000	204,000	17,000	2,000	696,000
Evaluation unit no. 3					
Site 8	485,000	209,000	2,000	1,000	697,000
Channel Improvement	68,000	29,000	10,000	1,000	108,000
Subtotal	553,000	238,000	12,000	2,000	805,000
Evaluation unit no. 4					
Site 9	173,000	74,000	1,500	500	249,000
Site 10	117,000	50,000	500	500	168,000
Site 11	185,000	80,000	1,500	500	267,000
Site 12	255,000	110,000	500	500	366,000
Site 13	122,000	52,000	500	500	175,000
Channel Improvement	132,000	44,000	2,500	500	179,000
Subtotal	984,000	410,000	7,000	3,000	1,404,000
Total	2,919,000	1,196,000	75,000	10,000	4,200,000

1/ Price base: 1969

Table 5, Annual cost, Walnut Creek Watershed, El Rio en Medio Subbasin Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
No. 1, FRS 1, 2, 3, 4, and channel improvement	63,380	3,600	66,980
No. 2, FRS 5, 6, and channel improvement	34,220	1,900	36,120
No. 3, FRS 8 and channel improvement	39,580	2,200	41,780
No. 4, FRS 9, 10, 11, 12, 13 and channel improvement	69,030	3,900	72,930
Total	206,210	11,600	217,810

1/ Amortized at 4 7/8 percent interest for 100 years (rounded to nearest $10)
2/ Adjusted normalized prices

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Floodwater			
Agricultural	187,200	8,000	179,200
Urban	28,300	-	28,300
Indirect	21,500	800	20,700
Total	237,000	8,800	228,200

1/ Based on adjusted normalized prices

Table 7, Comparison of Benefits and Costs for Structural Measures, Walnut Creek Watershed, El Rio en Medio Watershed, Upper Rio Grande Basin, New Mexico

Evaluation unit	Average annual benefits: Flood prev. damage red.	Redevelopment	Secondary	Total	Average annual cost	Benefit cost ratio
No. 1, FRS 1, 2, 3, 4, & chan. impr.	78,800	14,200	7,520	100,600	66,980	1.5:1
No. 2, FRS 5, 6, & chan. improvement	43,300	7,390	4,130	54,820	36,120	1.5:1
No. 3, FRS 8 & chan. impr.	53,200	8,630	5,060	66,890	41,780	1.6:1
No. 4, FRS 9, 10, 11, 12, 13, & chan. impr.	52,900	15,360	5,200	73,460	72,930	1.0:1
Total	228,200	45,580	21,910	295,770	217,810	1.4:1

1/ Adjusted normalized prices

LEGEND

- FLOODWATER RETARD STRUCTURE
- (2) SITE NUMBER
- 1 GOOD RANGE MGT.
- 3-5 MESQUITE BRUSH MGT.
- 3-3 CREOSOTE BRUSH MGT.
- 5 BOTTOMLAND VEGETATION MGT. AREA
- 6a IRRIGATED LAND MGT.
- 8 CRITICAL EROSION AREA
- COUNTY BOUNDARY
- CANAL
- BRIDGE
- RAILROAD
- PAVED HIGHWAY (2-Lane)
- DIVIDED HIGHWAY
- UNIMPROVED ROADS
- INTERMITTENT STREAM
- HOUSE

N

Scale

2 1 0 1 2 3 4 Miles

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
WALNUT CREEK WATERSHED
UPPER RIO GRANDE BASIN

NACIMIENTO AND RITO LECHE CREEK WATERSEHED

Sandoval and Rio Arriba Counties, New Mexico
CNI #1e-12

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located in Sandoval and Rio Arriba Counties, New Mexico, in the vicinity of Cuba which is about 80 miles northwest of Albuquerque, New Mexico, on State Highway 44. The watershed has a drainage area of about 18 square miles, of which 50 percent is private land and 50 percent is administered by the United States Forest Service.

The two main drainages in the watershed are the Rito Leche and Nacimiento Creek which are tributaries to the Rio Puerco.

The headwaters of the watershed are in the mountain range east of Cuba, and they drain in a westerly direction passing through Cuba and the surrounding irrigated land. They empty into the Rio Puerco Channel about two miles west of Cuba.

The Cuba population is about 1,000. There are about 350 acres of irrigated cropland in the damage area of the watershed. This cropland is owned by about 50 operators. The cropland is devoted mostly to the production of alfalfa, small grains, grass or pasture, and gardens. The principal land use in the watershed is for grazing of livestock.

Mean sea level elevations range from about 6,900 feet at the confluence of Nacimiento Creek and Rio Puerco to about 10,000 feet in the mountains.

The watershed is in the Southern Rocky Mountains Land Resource Area. The average annual precipitation is about 12 inches at Cuba and 20 inches in the mountains. The average annual temperature is about 47° F. with a high on record of 102° F. and a low of minus 40° F.

The watershed is within the Four-Corners Economic Development Region.

The Cuba District of the Santa Fe National Forest administers about 33,000 acres of this watershed. There are 11,000 acres within the San Pedro Parks Wilderness. Approximately 8,000 acres of the area outside the Wilderness are classed as commercial forest, 11,000 acres are non-commercial and 3,000 acres are brushland.

Watershed Problems and Needs

High-intensity rains, which occur from June through October, fall on steep slopes with sparse vegetative cover resulting in frequent damaging floods. Damaging floods occur on an average of once every three years. Major fixed improvements such as houses, businesses, motels, roads, and streets receive most damage. The major floodwater and sediment damages are caused by overbank flooding of Rito Leche and Nacimiento Creek. Both of the channels through the damage area are so small that they overflow on the average of every two years.

The damaging storms that could be remembered by the local people occurred in 1958, 1963, and 1968. Information available on the flood of 1968 indicated damage to about 200 acres of irrigated cropland, 17 houses and businesses, three irrigation diversion headings, and STate Highway 44. Traffic was held up for several hours due to flooding of the highway.

Damaging floods occur on an average of once every three years. Major fixed improvements such as houses, businesses, roads and streets receive most damage. The value of these improvements ranges from a few thousand dollars to well over $100,000.

Floodplain of Nacimiento Creek and Rito Leche, east of Cuba, New Mexico

SCS PHOTO 12-P990-13

It is estimated that the agricultural area flooded by the 100-year frequency storm is about 350 acres. This area is used mainly for production of alfalfa, corn, and irrigated pasture, and a small amount of vegetables. Agricultural damage amounts to an average of about $1,695 annually. The most significant flood hazard is the potential for damage in the urban area of Cuba. After future urban development and housing construction, average annual urban damage is estimated to be $54,805. Average annual indirect damages associated with flooding would be about $5,650.

Erosion rates range from moderate to severe, foothill areas being the most susceptible to erosion.

Water-based recreation and storage of water for municipal use is needed. More intensive application of land treatment measures and better control of grazing and other flood prevention measures are also necessary. Approximately 10 percent of the watershed has critical erosion problems. Grazing management is needed on all areas, since most rangeland suffers from overuse. Twenty percent of the watershed is producing sagebrush and chaparral brush which need to be controlled. Eleven percent of the watershed is woodland growing on soil and slope conditions adaptable to control. Chaparral is not shown on the land treatment map because it is intermingled with pinyon-juniper and ponderosa pine areas.

Cultivated land comprises two percent of the watershed of which about 455 acres need improved irrigation systems. About 2,560 acres of this watershed is in the wilderness area and no land treatment is planned.

Physical Potential for Meeting Needs

There has been very little accomplished toward flood protection in the watershed. Some channel enlargement has been done on the Rito Leche, but it is inadequate.

Two floodwater retarding structures and two floodwater diversion sites were located, and it was determined that these structures were physically feasible and would meet the needs for flood protection. It is possible one of these structures could be a multiple-purpose structure including recreation and municipal water storage in addition to flood prevention.

The topography, soils, and geology at these sites are favorable for installation of the structural measures. Structure sites are located in the Kirtland Shale and Ojo Alamo Sandstone of Cretaceous age. All excavation would be common. Adequate clay and clayey sand is available for borrow. Cutoff depths into underlying shale would be less than 15 feet.

Local Interest in Project Development

The local people are extremely interested in solving flood problems. In the past, the people have asked for assistance, but until now the project

did not appear feasible. The local people are willing to do everything necessary to qualify for assistance under the Public Law 566 program. In addition to flood protection, the local people are interested in obtaining storage for recreation and municipal water.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Pinyon-juniper control on 1,040 acres of woodland.

(b) Sagebrush control on 1,630 acres of brushland.

(c) Chaparral control on 250 acres of brushland.

(d) Good management of 850 acres of ponderosa pine for commercial use.

(e) Good management of 450 acres of aspen.

(f) Phreatophyte control on 30 acres of land.

(g) Improved irrigation facilities on 455 acres of irrigated land.

(h) Good management of 350 acres of abandoned cropland.

(i) Erosion control on 1,350 acres of critically eroded land. These areas are generally on steep, poorly vegetated unstable soils and in heavily used areas near farmsteads and urban areas. Effective methods that may be used on areas subject to erosion are gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

The National Forest Project Work Inventory lists vegetation control for enhancement of range and water yield, timber stand improvement for commercial forests, fuel control for forest protection and erosion control for land stabilization as needed on the watershed. All these needs should be considered when the project work plan is prepared.

Structural Measures

Reconnaissance of the watershed and discussion with local people indicate that flood damage occurs to the town of Cuba quite frequently. It has been determined that two floodwater retarding structures, one on Rito

Soft shale exposures in the Rito Leche Watershed SCS PHOTO 12-P993-3

Deep gullies in shale alluvium on Rito Leche Watershed SCS PHOTO 12-P993-1

Leche, the other on Nacimiento Creek with an outlet channel, and two floodwater diversions would provide the needed flood protection for the town of Cuba. These measures would be single-purpose flood control structures.

Nature and Estimate of Costs of Improvements

Structural data were determined from U. S. Geological Survey quad maps of the area and a centerline profile of the proposed floodwater retarding structures.

The major items of construction in the project would be earthwork and two stabilizing structures in the diversions. Floodwater diversion 2 would cross State Highway 26 requiring a steel culvert.

The potential retarding structures and the pool areas on both structures would be located on land that is presently pasture, some of which is irrigated. The diversions would cross pasture land while the outlet channel for site 1 and floodwater diversion 2 would follow the existing channel.

Effects and Economic Feasibility of Potential Development

It is estimated that the agricultural area flooded by the 100-year frequency storm is about 350 acres of land used mainly for the production of alfalfa, corn, and irrigated pasture. Agricultural flood damages are estimated to be $1,695 annually and would be reduced by about 90 percent with the installation of the project measures. This reduction would provide benefits in the amount of $1,525 per year. With the installation of structural measures for flood prevention, urban damage could be controlled resulting in $54,805 in average annual benefits and provide a high degree of flood protection to approximately 150 homes and business building in the town of Cuba. Indirect damages could be reduced from $5,650 to about $50 annually yielding additional benefits of $5,600.

The sum of the above damage reduction benefits is $61,930. Other project benefits from redevelopment and secondary sources amount to $17,170 and, when added to damage reduction benefits of $61,930 provide a total of $79,100. When these benefits are compared to the annual equivalent cost of structural measures a benefit-cost ratio of 1.4 to 1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures. These systems are primarily designed to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $18,500. The average annual return is estimated to be $61,400.

Alternate or Additional Possibilities

Alternate structure locations are available for controlling the floodwater from the creeks and should be investigated when detailed plans are developed. It is possible that permanent storage could be provided for recreation and municipal and industrial storage.

Table 1, Structure Data, Nacimiento and Rito Leche Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surf. area em. spwy. level	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	6.5	83	620,300	RC conduit	8	RC chute	1	80	c
2	6.9	74	416,500	RC conduit	8	RC chute	1	61	c

Table 2, Reservoir storage capacity

Site number	Drainage area	Storage capacity planned		
		Sediment	Detention	Total
	(sq. mi.)	- - - - - acre-feet - - - - - -		
1	6.5	294	698	992
2	6.9	316	742	1,058

Table 3, Channel data, Nacimiento and Rito Leche Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach	Watershed area	Needed channel capacity	Bottom width	Depth	Velocity in channel	Estimated volume of excavation
	(100 ft.)	(sq.mi.)	(cfs)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
Floodwater diversion 1	45	0.6	500	40	3.0	4.9	23,000
Floodwater diversion 2	30	0.25	270	20	2.7	4.0	21,300
Outlet channel for site 1 & FWD 2	40	-	500	40	3.0	4.0	23,000

Table 4, Distribution of structural cost - potential development, Nacimiento and Rito Leche Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Floodwater retarding structure, site 1, Rito Leche	383,000	165,000	19,500	500	568,000
Floodwater retarding structure, site 2, Nacimiento Creek	284,000	122,000	19,500	500	426,000
Floodwater diversion 1	22,000	10,000	500	500	33,000
Floodwater diversion 2	13,000	6,000	500	500	20,000
Outlet channel	22,000	10,000	2,000	1,000	35,000
Total	**724,000**	**313,000**	**42,000**	**3,000**	**1,082,000**

1/ Price base: 1969

Table 5, Annual cost, Nacimiento and Rito Leche Creek Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of install. Cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
FRS 1, 2, and FWD 1, 2, and outlet channels	53,200	2,720	55,920

1/ Amortized at 4 7/8 percent interest for 100 years (rounded to nearest $10)
2/ Based on adjusted normalized prices.

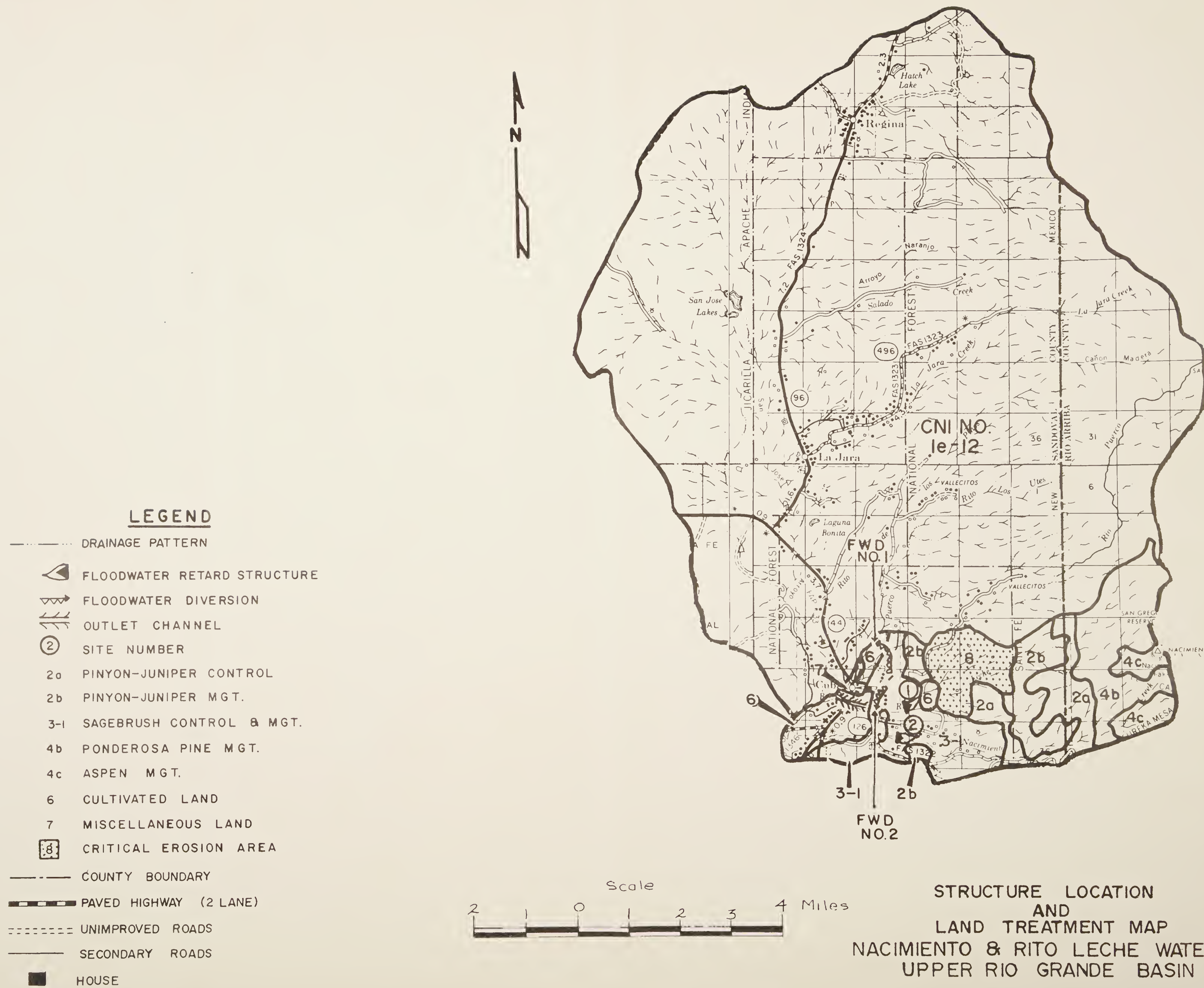
Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Floodwater			
Crop & pasture	1,695	170	1,525
Urban	54,805	-	54,805
subtotal	56,500	170	56,330
Indirect	5,650	50	5,600
Total	62,150	220	61,930

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Average annual benefits: Redevelopment	Average annual benefits: Secondary	Average annual benefits: Total	Av. annual cost	Benefit-cost ratio
FRS 1, 2, and FWD 1, 2, and outlet channel	61,930	11,270	5,900	79,100	55,920	1.4:1

1/ Adjusted normalized prices



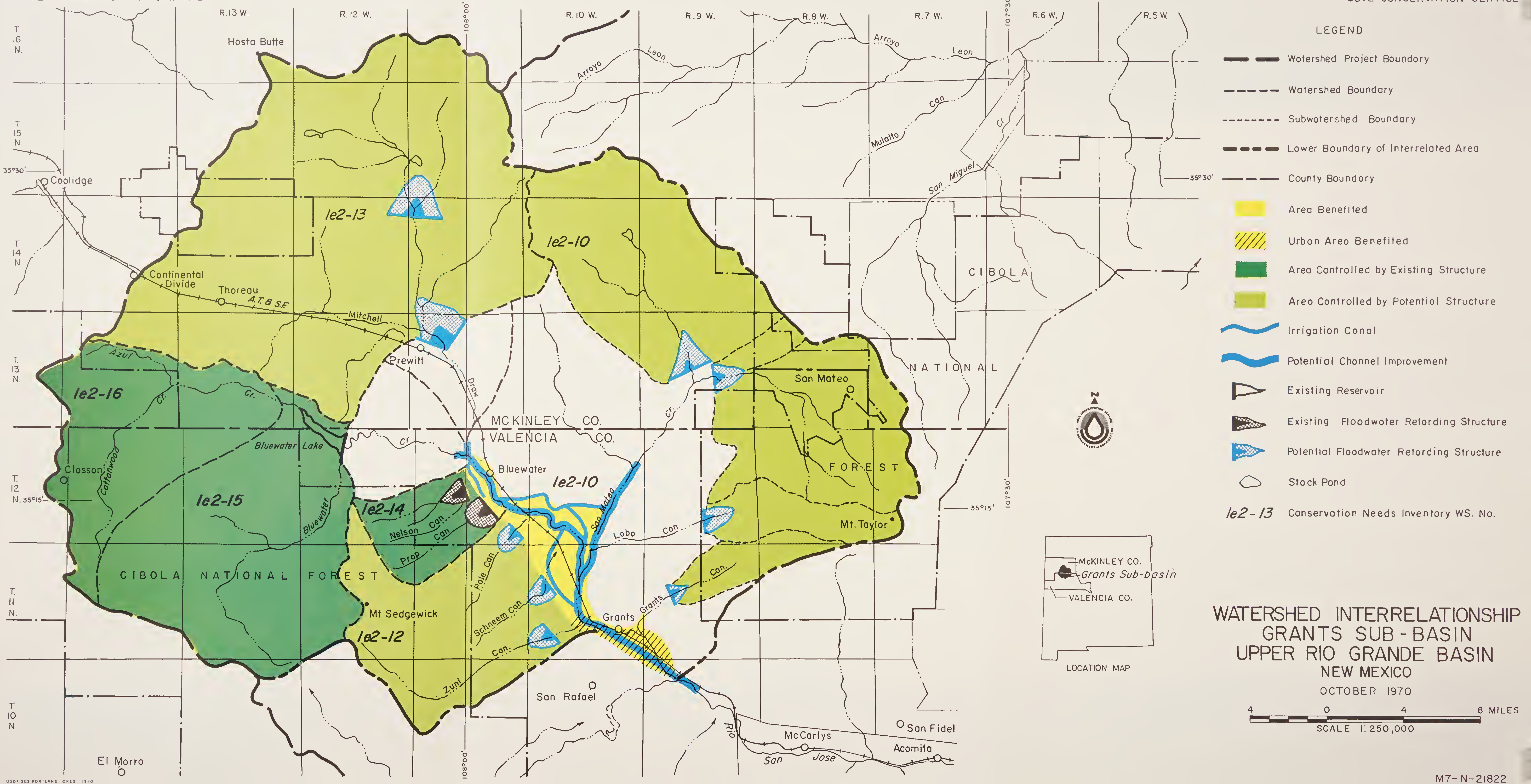
STRUCTURE LOCATION
AND
LAND TREATMENT MAP
NACIMIENTO & RITO LECHE WATERSHED
UPPER RIO GRANDE BASIN

San Mateo-Grants Canyon, Rio San Jose, and Pole-Zuni Canyon Watersheds form a combination which contribute flood flows to a common floodplain. This floodplain includes agricultural areas and the city of Grants. These three watersheds need to be considered simultaneously in a plan to effectively utilize watershed planning resources and arrive at the most economical combination of structural measures.

The following Watershed Interrelationship Map shows this relationship.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



WATERSHED INTERRELATIONSHIP GRANTS SUB-BASIN UPPER RIO GRANDE BASIN NEW MEXICO

OCTOBER 1970

USDA SCS PORTLAND, OREG 1970

M7-N-21822

POLE-ZUNI CANYON WATERSHED

Valencia County, New Mexico
CNI #1e2-12

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located west of the communities of Grants and Milan, New Mexico. It includes the drainages of Pole and Zuni Canyons and the area between the two canyons west of the Rio San Jose. The area is approximately 67,000 acres, most of which is in the Arizona and New Mexico Mountains Land Resource Area. Of this area about 32 percent is privately owned, 55 percent is in the Cibola National Forest, 8 percent is state land and 4 percent is administered by the Bureau of Land Management. There are about 2,900 acres of cropland previously irrigated from the Bluewater-Toltec Irrigation System and individual wells. The Grants Municipal Airport, much of the town of Milan, and a newly developed golf course west of Milan are in the lower part of the watershed.

The 37,800 acres of National Forest in this watershed are in the Gallup District of the Cibola National Forest and are classed as 26,400 acres of commercial forest, 9,500 acres non-commercial forest, and 1,900 acres of grassland.

Watershed Problems and Needs

The entire watershed is a tributary to the Rio San Jose, which passes through Milan and Grants. Floods on the Rio San Jose cause flooding in the east end of Grants. Much of the recent development in Grants is located in the floodplain and is subject to, or receives damage from floods. In 1967 the recently developed Milan Country Club and golf course was damaged from a flood on the arroyo by Schneeman's Ranch. The flooding extended into some homes in Milan.

Much of the 2,900 acres of cropland previously irrigated is now lying idle due to flood damage and lack of water for irrigation systems. Flood control measures are needed in order to place high-value farmland in full production, prevent damage to homes and businesses in Milan, provide protection for the Grants Municipal Airport, and reduce the contributing flow to the Rio San Jose so as to lessen the flooding in Grants.

The estimated average annual floodwater damage to crops, hay, other agricultural, and public utilities amounts to $7,800 based on adjusted normalized prices. Average annual urban damages within this watershed amount to about $26,100. Agricultural and urban damages combined make a total of $33,900.

Pole-Zuni Watershed and drainage area from Black Mesa overlooking Milan, New Mexico SCS PHOTO 12-P992-6

Approximately 25 percent of the grassland needs critical area management. These areas are adjacent to the irrigated land and have been heavily grazed. Some of the irrigable bottomland soils are clayey. When irrigation water that is high in soluble salt is applied to crops, the salt content tends to build up rather than leach through the profile. These clayey soils need special attention and special crops.

Physical Potential for Meeting Needs

The needs for flood protection in the watershed can be met partially by good range management supplemented by structural measures, and additional measures in the two adjoining watersheds (Rio San Jose and San Mateo-Grants). There are three sites suitable for floodwater retarding structures that have been selected. Topography and other physical conditions are favorable for construction of a floodwater diversion west of the town of Milan and the Grants airport. To provide an adequate outlet channel and prevent adding to the flood damage to the town of Grants, a flood bypass channel will need to be constructed south of Grants and the railroad to carry the flow of the Rio San Jose.

Vegetative cover conditions range from poor to fair from a forage standpoint and generally poor as retarding agents for rainfall runoff.

About 11 percent of the watershed has soil and slope conditions adaptable to clearing pinyon and juniper areas of trees and brush and seeding to grass. Managing rangeland efficiently is made difficult because of limited potential for livestock watering devices. One solution is to create artificial watersheds using plastic or asphalt catchment areas and a storage tank.

The potential structural sites are not particularly suited for recreation pools due primarily to a lack of water and high evaporation rate.

Local Interest in Project Development

Residents in the area of Grants and Milan are actively trying to promote a flood protection project. The community governing bodies are making an effort to promote a project that would provide protection for existing development and permit continued development and growth in the towns.

An application has been submitted to the Secretary of Agriculture by local organizations for assistance under Public Law 566 to solve flood problems on Pole Canyon. Applications for assistance on San Mateo and the Rio San Jose Watersheds, both adjacent watersheds, have been submitted. The local people in positions of leadership acknowledge the necessity for coordinating the efforts of the entire area of the three applications because of the common need for flood protection measures.

The local organizations responsible for submitting the applications are the Lava Soil and Water Conservation District, the town of Grants, the village of Milan, the Bluewater-Toltec Irrigation District, Valencia and McKinley Counties. These organizations possess the legal authority necessary to meet the needs of any potential project in the watershed.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Snowpack management on 8,800 acres of grassland.

(b) Pinyon-juniper control on 7,600 acres of land.

(c) Ponderosa pine management on 19,400 acres of commercial timberland.

(d) Improved irrigation systems on 2,300 acres of irrigated land.

(e) Erosion control on 2,300 acres of critically eroded land.

The National Forest Project Work Inventory lists need for timber stand improvement, vegetative manipulation, fuel treatment, and land treatment for erosion control as desirable projects that should be considered in the work plan preparation for this watershed.

Structural Measures

The potential structural measures within this watershed are floodwater retarding structures on Zuni Canyon, Schneeman Draw, and on Pole Canyon, and a floodwater diversion from Schneeman Draw around westof the Grants Ariport to Zuni Canyon. A potential measure necessary for complete protection is a bypass channel south of Grants, in the San Mateo-Grants Canyon Watershed. These potential structural measures are single purpose flood protection measures. With the potential structures installed, 65.2 square miles (63 percent) of the watershed will be in the controlled area. The potential structure sites are all classed as "c" high-hazard structures.

Nature and Estimate of Costs of Improvements

The basis for estimating costs of the potential structures was developed from United States Geological Survey 7 1/2 minute quadrangle sheets. A stage storage curve was developed for the floodwater retarding structures to obtain estimated capacity. A surveyed centerline was used for earthwork computations. The required storage is based on the expected 100-year sediment yield and the flood from a 1 percent chance storm. The flood water diversion was planned using the map data and expected flows from a 1 percent chance storm.

The estimated cost of the floodwater retarding structures was based on a unit cost per cubic yard of earthfill as determined from a 1969 unit cost curve. The curve was developed from data obtained in watershed work plans that are being readied for construction. The cost of the floodwater diversion was based on a unit cost per cubic yard of fill; the unit cost was obtained from similar projects throughout the state. Land rights and easements were estimated from field observations and map data using cost data from similar conditions in the state.

Effects and Feasibility of Potential Development

The estimated average annual floodwater damage to crops, hay, other agricultural, and public utilities amounts to $7,800 based on adjusted normalized prices. Average annual urban damages in and near the village of Milan amount to about $26,100. Agricultural and urban damages combine to make a total of $33,900. After project measures are installed, these damages will be reduced to $4,500 or a damage reduction of about 87 percent. The value of local secondary benefits which will accrue to the project is estimated to be $3,080 annually. They will accrue as a

result of increased net income to producers of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project.

The average annual project benefits are estimated to be $37,060, and the average annual costs of structural measures $23,875. This results in a benefit-cost ratio of 1.6 to 1.

Redevelopment benefits associated with watershed project measures are estimated to be $4,580 annually. These benefits would accrue to presently unemployed local labor which would be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization. Total average annual cost for the land treatment systems is estimated to be $252,200. The average annual return is estimated to be $381,900.

Alternatives and Additional Possibilities

The potential project presented in this report is the only logical and feasible method of controlling the flood damages in the area.

There is some potential for recreation development on both Pole and Zuni Canyons.

Table 1, Structure data, Pole-Zuni Canyon Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surf. area em. spwy. level	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	32.8	56	75,730	RC conduit	8	Rock	1	76	c
2	5.4	27	76,300	RC conduit	8	RC chute	1	30	c
3	26.8	38	15,600	RC conduit	8	Rock	1	80	c

Table 2, Channel data

Channel designation	Length of reach	Watershed area	Needed channel capacity	Bottom width	Depth	Velocity in Channel	Estimated volume of excavation
	(100 ft.)	(sq.mi.)	(cfs)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
Floodwater diversion	31	5.6	1,400	6	7	6.0	140,000

Table 3, Distribution of structural cost -- potential development, Pole-Zuni Canyon Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost: Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Site 1, Zuni Canyon	61,000	34,000	13,500 2/	500	109,000
Site 2, Schneeman Draw	86,000	37,000	2,500	500	126,000
Site 3, Pole Canyon	30,000	17,000	500	500	48,000
FWD #1	107,000	39,000	2,500	500	149,000
Total	284,000	127,000	19,000	2,000	432,000

1/ Price base: 1969
2/ Includes cost of relocating a section of county highway.

Table 4, Reservoir storage capacity

Site number	Drainage area	Storage capacity planned: Sediment	Detention	Total
	(sq.mi.)	- - - - - acre-feet	- - - - -	
1	32.8	268	989	1,257
2	5.4	60	118	178
3	26.8	226	580	806

Table 5, Annual cost, Pole-Zuni Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of install. cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
Site 1, Zuni Canyon	5,360	300	5,660
Site 2, Schneeman Draw	7,000	375	7,375
Site 3, Pole Canyon	2,360	150	2,510
FWD #1	7,330	1,000	8,330
Total	22,050	1,825	23,875

1/ Amortized at 4 7/8 percent interest for 100 years (rounded to nearest $10)
2/ Adjusted normalized prices

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

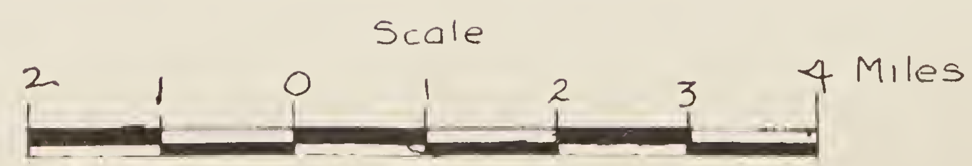
Item	Est. average annual damages: Without project	Est. average annual damages: With project	Damage reduction benefits
Floodwater			
Agricultural	7,800	1,900	5,900
Urban	26,100	2,600	23,500
Total	33,900	4,500	29,400

1/ Based on adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Average annual benefits: Redevelopment	Average annual benefits: Secondary	Average annual benefits: Total	Average annual cost	Benefit-cost ratio
FRS 1, 2, 3 and FWD 1	29,400	4,580	3,080	37,060	23,875	1.6:1

1/ Based on adjusted normalized prices



STRUCTURE LOCATION
AND
LAND TREATMENT MAP
POLE-ZUNI CANYON WATERSHED
UPPER RIO GRANDE BASIN

R I O   S A N   J O S E   W A T E R S H E D

Valencia and McKinley Counties, New Mexico
CNI #1e2-13

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed, located generally north of Bluewater Lake and Bluewater village, is in the northern edge of Valencia County and the south central part of McKinley County. It includes the entire drainage area to the Rio San Jose above the Bluewater Village of approximately 224,600 acres (351 square miles). The major part of the watershed is in the New Mexico and Arizona Plateaus and Mesas Land Resource Area.

Of the total area, about 47 percent is privately owned, 37 percent is Indian land, 9 percent is managed by the Bureau of Land Mangement, and 7 percent is state land. There are about 1,500 acres of irrigated farm land under the Bluewater-Toltec Irrigation District that lie in the low flat area of this drainage and the San Mateo Creek drainage. The Atchison-Topeka and Santa Fe Railroad passes through the watershed part of which is subject to flooding and damage.

There are several industrial plants in the lower regions of the watershed that contribute to the economy of the area.

Watershed Problems and Needs

This watershed and the San Mateo Creek drainage contribute most of the floodwaters that damage cropland and urban and industrial property downstream. Floodwaters damage truck and field crops, homes, businesses, residential areas of Grants and Milan, U. S. Highway 66, and the Atchison, Topeka, and Santa Fe Railroad. Some damage is also sustained by some of the installations of the uranium refining plants.

To adequately solve the flooding problems, this watershed should be planned in conjunction with the San Mateo-Grants Canyon Watershed and the Pole-Zuni Canyon Watershed. Land treatment and structural and management measures to reduce the damaging flood flows into the developed area around Grants and Milan are needed.

The estimated average annual floodwater damage to crops, hay, other agricultural and public utilities amounts to $32,700 based on adjusted normalized prices. Average annual urban damages within the watershed amount to about $109,100. Agricultural and urban damages combined make a total of $141,800.

Rio San Jose approaching Grants, New Mexico, looking southwest from railroad overpass

SCS PHOTO 12-P992-2

Rio San Jose entering Grants. Looking north from railroad overpass

SCS PHOTO 12-P992-1

Physical Potential for Meeting Needs

Within the watershed boundary much of the needed protection and rehabilitation can be accomplished by land treatment measures and proper range management. To control the floodwater that contributes to damage in the Grants, Milan, and Bluewater area, supplemental floodwater retarding structures will be required to reduce the flow to a level that can safely pass through the developed area downstream.

From a reconnaissance study of possible sites for floodwater retarding structures, it appears that physical conditions are suitable for development. Some areas of high sodium content soils occur and might pose problems in construction.

The existing channel from Bluewater to Grants could be rehabilitated and probably enlarged to discharge the controlled release from a potential structural program. The potential floodwater retarding structures are not suited to recreation due primarily to a lack of water needed to maintain a permanent pool.

An area of very sandy soil occurs north of the railroad near Thoreau. Wind erosion control could make this soil some of the more productive in the watershed. Two areas of clayey alluvial soils, one near Smith Lake and another north of Prewitt, are adaptable to practices such as contour furrowing or pitting. The permeability rates are very slow.

Local Interest in Project Development

The local residents are actively promoting a project designed to afford protection from floods in the Bluewater, Milan, and Grants area. The community governing bodies, the local soil and water conservation districts and county commissions are all participating in the promotion of planning a flood protection project.

An application for assistance under Public Law 566 was submitted to the Department of Agriculture in 1965. The area covered by the application contributes flood damage not only to developed areas in the watershed but also in the Pole-Zuni Canyon and the San Mateo-Grants Canyon Watersheds. The local people recognize this and have applied for assistance on the three contributing watersheds. The organizations responsible for submitting the applications for assistance in flood protection have the necessary legal authorities to sponsor the proposed project.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by

keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Good range management on 82,900 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 31,100 acres of woodland.

(c) Good management of ponderosa pine on 2,200 acres of commercial timber land.

(d) Erosion control on 15,600 acres of critically eroded land.

Structural Measures

The potential structural measures in the watershed are two floodwater retarding structures, one near Prewitt, New Mexico, on the Rio San Jose, and the other near Andrews Ranch on Casamero Draw. The enlargement and rehabilitation of the existing channel from near Bluewater to Milan constitutes a distance of about 6.6 miles.

The potential structures are single-purpose flood protection measures and high-hazard class "c".

Nature and Estimate of Costs of Improvements

The estimated costs of the potential structural development were based on stage storage curves developed from U. S. Geological 7 1/2 minute quadrangle sheets supplemented with a surveyed centerline of the two floodwater retarding structures. The required storage was determined for the expected sediment yield for a 100-year period and a flood from a 1 percent chance storm. The estimated cost of the floodwater retarding structures was based on a unit cost per cubic yard of earthfill. The unit cost curve was plotted from planned structures with detailed cost estimates under similar conditions.

The land rights and easements costs were estimated by field observation, use of the U. S. Geological Survey quadrangle sheets and local unit prices for land.

Effects and Feasibility of Potential Development

The installation of the proposed structural measures will provide a high degree of flood protection to about 1500 acres of irrigable cropland in the watershed. Downstream damage reduction benefits to urban property in Milan and Grants would be realized. The estimated average annual flood

damages without project are $141,800. After project measures are installed, these damages will be reduced to $19,100, or a damage reduction of about 89 percent. About 92 percent of the area contributing to damages will be controlled.

The value of local secondary benefits accruing to the project amount to $13,000 annually. They accrue as a result of increased net income to producers and processors of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project and local effects of project operation and maintenance.

Redevelopment benefits associated with watershed project measures are estimated to be $17,100 annually. These benefits will accrue to presently unemployed local labor which will be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

The average annual cost of structural measures is estimated to be $81,350 and average annual benefits amount to $152,800. A benefit-cost ratio of 1.9 to 1 is derived.

Looking east over Grants. Rio San Jose enters at right center. Flooding occurs in the area shown across the center of the photo. SCS PHOTO 12-P993-16

The land treatment systems suggested for the watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

The total average annual costs for the land treatment systems are estimated to be $156,300. The average annual returns are estimated to be $205,300.

Alternate or Additional Possibilities

The potential flood control measures presented in this report are considered to be the only logical and feasible method of controlling floods from the contributing areas.

Table 1, Structure data, Rio San Jose Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surf. area em. spwy level	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
4	165.4	43	511,230	RC conduit	8	RC chute	1	1,120	c
5	129.5	46	49,410	RC conduit	8	Rock	1	540	c

Table 2, Channel data

Channel designation	Length of reach	Watershed area	Needed channel capacity	Bottom width	Depth	Velocity in Channel	Estimated volume of excavation
	(100 ft.)	(sq.mi.)	(cfs)	(ft.)	(ft.)	(ft./sec.)	(cu.yds.)
Rio San Jose Channel	350	320	3,000	100	6.5	4.1	412,200

Table 3, Distribution of structural cost - potential development (dollars) 1/

Structural measures	Installation cost: Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Site 4, Prewitt	880,000	378,000	1,000	1,000	1,260,000
Site 5, Andrews Ranch	41,000	23,000	1,500	500	66,000
Rio San Jose Channel	126,000	46,000	2,500	500	175,000
Total	1,047,000	447,000	5,000	2,000	1,501,000

Table 4, Reservoir storage capacity

Site number	Drainage area	Storage capacity planned: Sediment	Detention	Total
	(sq.mi.)	- - - -	acre-feet - - - -	-
4	165.4	2,970	6,600	13,570
5	129.5	2,178	5,180	7,358

Table 5, Annual cost

Evaluation unit	Amortization of install. cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
Site 4, Prewitt	61,950	3,500	65,450
Site 5, Andrews Ranch	3,300	200	3,500
Rio San Jose Channel	8,600	3,800	12,400
Total	73,850	7,500	81,350

1/ Total installation cost amortized at 4 7/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

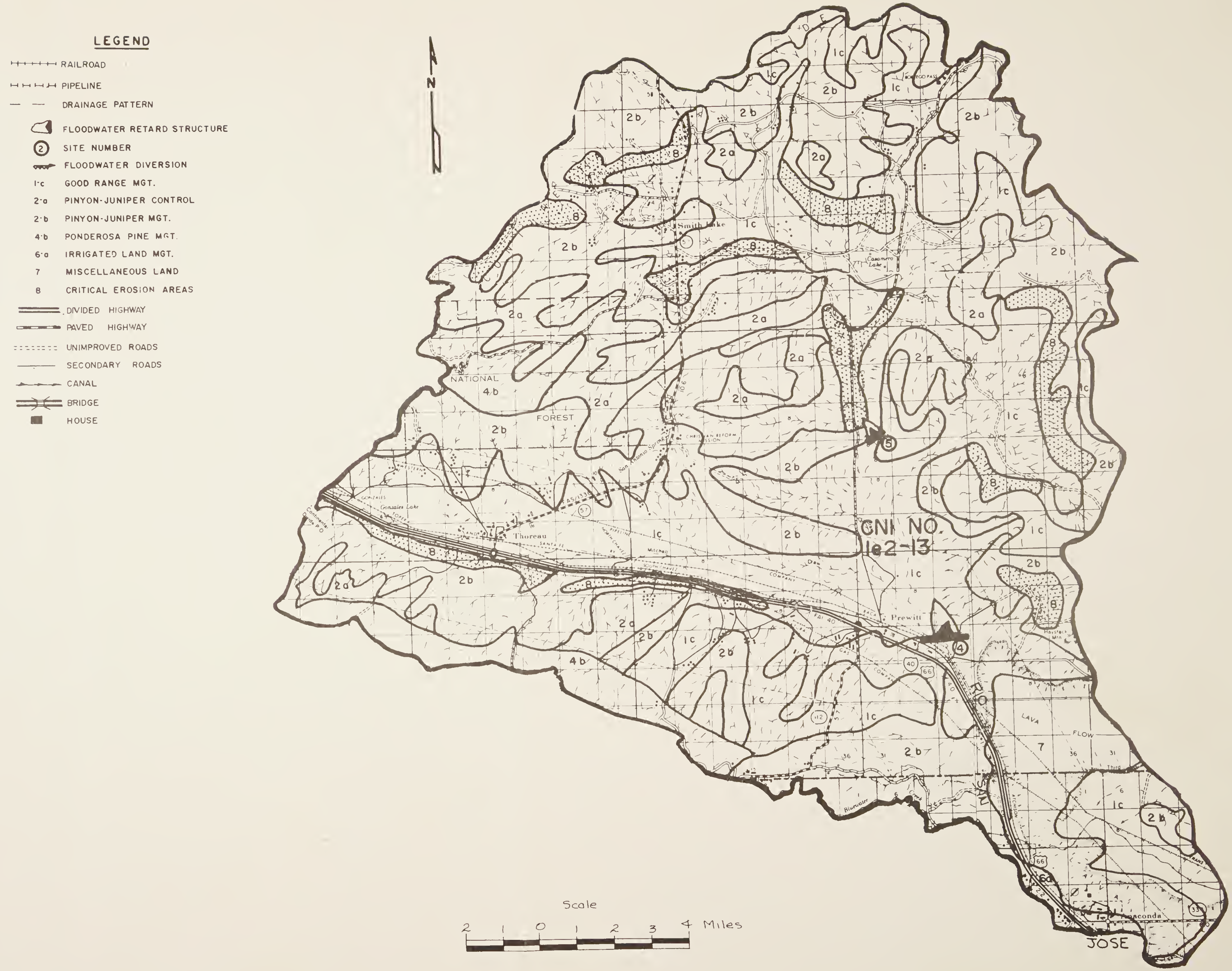
Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Floodwater			
Agricultural	32,700	8,200	24,500
Urban	109,100	10,900	98,200
Total	141,800	19,100	122,700

1/ Based on adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Average annual benefits: Redevelopment	Average annual benefits: Secondary	Average annual benefits: Total	Average annual cost	Benefit-cost ratio
FRS 4, 5, & Rio San Jose Channel	122,700	17,100	13,000	152,800	81,350	1.9:1

1/ Adjusted normalized prices



STRUCTURE LOCATION
LAND TREATMENT MAP
RIO SAN JOSE WATERSHED
UPPER RIO GRANDE BASIN

S A N M A T E O - G R A N T S C A N Y O N W A T E R S H E D

McKinley and Valencia Counties, New Mexico
CNI #1e2-10

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The San Mateo-Grants Canyon Watershed is located in McKinley and Valencia Counties in northwestern New Mexico. San Mateo Creek and Grants Canyon are tributaries to the Rio San Jose. San Mateo Creek enters the San Jose about 4 miles northwest of Grants, and Grants Canyon enters the river at the city of Grants.

The watershed covers an area of about 213,000 acres of which 114,420 acres are privately owned, 11,940 acres are state land, 19,360 acres are administered by the Bureau of Land Management, 58,000 acres are National Forest, 9,000 acres are Indian land, and 280 acres are State Game Department land.

The land administered by the Forest Service is a part of the Cibola National Forest. About 11,700 acres are classed as commercial forest and 41,000 acres as non-commercial forest, 5,300 acres are classed as grasslands.

Important development in the watershed include the Homestake Company Uranium Plant, the Atchison, Topeka and Santa Fe Railroad, U. S. Highway 66, the city of Grants, and part of the Village of Milan.

The watershed is located in the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. It is included in the Datil section of the Colorado Plateaus physiographic province.

Elevations range from 6,420 feet above mean sea level at Grants to 11,389 feet on Mount Taylor. Average annual rainfall is about 12 inches. Much of the watershed is grazing land with highly productive agricultural land in the broad level valley northeast of Milan. High-value truck crops are grown on much of this irrigated area. The watershed is within the Four-Corners Economic Development area.

Watershed Problems and Needs

San Mateo-Grants Canyon, San Jose, and Pole-Zuni Creeks Watershed form a combination of watersheds which contribute flood flows to a common floodplain. This floodplain includes agricultural areas and the city of Grants. These three watersheds need to be considered simultaneously in a plan to effectively utilize watershed planning resources and arrive at the most economical combination of structural measures.

Uranium mining area near Ambrosia Lake SCS PHOTO 12-P993-11

Abandoned mine site near Ambrosia Lake SCS PHOTO 12-P993-10

San Mateo Creek drains through a productive farmland area where no well-defined channel exists. Floodwaters cross the Atchison-Topeka and Santa Fe Railroad and U. S. Highway 66. The waters unite with the Rio San Jose and pass through the village of Milan. Floods from Zuni Canyon enter the city of Grants where Grants Canyon flows enter the river.

Floods from these drainages, individually and combined, have resulted in flooding and silt deposits in the Rio San Jose in Grants, and irrigated cropland. The resulting flood damage is to farmland, city streets, approximately 200 homes in Grants, the Atchison-Topeka and Santa Fe Railroad and to U. S. Highway 66.

In August and September of 1967 heavy rains in the area caused intensive damage in Grants to streets, bridges, and homes. On four occasions, the sewage disposal plant was completely inundated by water. If flooding continues, the disposal plant will become completely inoperative.

The estimated average annual floodwater damage to crops, hay, and other agriculture, and roads and bridges amounts to about $23,300 based on adjusted normalized prices. Average annual urban damages within this watershed amount to about $73,500. Agricultural and urban damages combined make a total of $96,800.

A principal need is treatment of critical erosion areas. Many of these areas have been caused by industrial exploration by mining companies and include abandoned mine sites, roads, and trails where the natural vegetation has been destroyed. Irrigated croplands need measures which will improve the application and conservation of water.

Physical Potential for Meeting Needs

Due to low rainfall and high evaporation, surface water storage for any purpose is not feasible in the potential structures. There are adequate sites to control most of the flooding originating in the watershed.

The channel capacity of the Rio San Jose could be increased thereby preventing the flow from entering the city of Grants by a bypass channel south of the railroad. With a channel to keep the Rio San Jose from going into Grants, the only flood hazard to the town would be Grants Canyon which could be controlled by a retarding structure. Sediment deposition in the east edge of Grants would be confined to the channel which could be effectively maintained by cleaning.

Local Interest in Project Development

The watershed is in the Lava Soil and Water Conservation District. The district supervisors and the officials of the city of Grants, as well as other local citizens are actively promoting a project for flood protection in the area.

An application has been submitted for assistance under Public Law 566 to solve flood problems in the watershed. On the recommendation of the Soil Conservation Service, the application was amended to include Grants Canyon to coordinate better the over all planning for protection in this watershed and the two adjacent ones, Pole-Zuni Canyon and the Rio San Jose. The application for assistance was submitted by the Lava Soil and Water Conservation District, the city of Grants, village of Milan, Bluewater-Toltec Irrigation District, McKinley Soil and Water Conservation District, and East Valencia Soil and Water Conservation District. The sponsors have the legal authority to sponsor, operate, and maintain a project.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Good range management on 59,172 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 37,812 acres of woodland.

(c) Good management of ponderosa pine on 1,000 acres of commercial timber land.

(d) Improved irrigation systems on 1,940 acres of irrigated land.

(e) Erosion control on 20,048 acres of critically eroded land.

Needs as listed in the National Forest project work inventory include erosion control vegetative manipulation, timber stand improvement and fuel treatment - all of which will be considered when the project work plan is prepared.

Structural Measures

From a reconnaissance of the watershed, four potential floodwater retarding sites were selected to provide the storage necessary to control the contributing floods in the watershed. The potential structures would control about 204 square miles or about 64 percent of the watershed. The structures would all be single-purpose flood control structures.

Proposed structure site in Lobo Canyon used as a solid waste disposal area

SCS PHOTO 12-P993-14

Looking west toward Grants from proposed Lobo Canyon structure site

SCS PHOTO 12-P993-15

Sites 6, 7, and 8 will control contributing flow to the Rio San Jose above Milan and Grants. Site 9 on Grants Canyon will control the flows directly into the city of Grants.

A bypass channel for the Rio San Jose south of the town and railroad tracks would keep the river flow from entering the city of Grants. This channel carrying the flow from the principal spillway of the structures above and also flows from the uncontrolled areas would convey the flows past the damaged area in the city and safely discharge into the existing river channel below the city. In addition to controlling the Rio San Jose, drainage in the city would be improved due to a much smaller flow.

Nature and Estimate of Costs of Improvements

The estimate of costs for the potential floodwater retarding structures was developed from data obtained from U. S. Geological Survey 7 1/2 minute quadrangle sheets and a surveyed centerline. A stage storage curve was developed from the quad sheets. Earthfill quantities were estimated from the surveyed centerline profile. The estimated storage was based on the expected 100-year sediment yield and the expected volume of runoff from a 1 percent chance storm. Data for the bypass channel was taken from the quad sheets. The channel is designed to carry the released flow from the control structures and from the uncontrolled area.

The estimate of cost for earthfill is based on a unit cost per cubic yard from a 1969 curve of unit cost. The curve was developed from detailed cost estimates of similar structures in New Mexico. Other unit costs were based on similar type construction and on the judgment of engineers. Land rights costs were estimated from field observations using cost data from similar conditions in the State.

At site 6, approximately 2.1 miles of State Highway 509 would have to be relocated. The estimated cost was based on a unit cost per square yard of surface area for completed road. The unit cost is the same as used by other agencies in New Mexico.

Effects and Feasibility of Potential Development

The installation of structural measures proposed in this report would provide a high degree of protection from flood damage to approximately 400 acres of irrigable land and to about 400 homes and 40 commercial developments in Grants and Milan. Average annual flood damages without the project are estimated to be $96,800. After project measures are installed, these damages will be reduced to $12,000, or a damage reduction of about 88 percent.

The value of local secondary benefits accruing to the project amount to $9,600 annually. They accrue as a result of increased net income to producers and processors of farm products and to suppliers of equipment and

materials required to achieve the increased production made possible by the project.

Redevelopment benefits associated with watershed project measures are estimated to be $17,200 annually. They will accrue to presently unemployed local labor which will be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvements, development, and preservation of watershed resources and their optimum utilization.

Total average annual cost for the land treatment systems is estimated to be $170,900. The average annual return is estimated to be $302,800.

Alternate or Additional Possibilities

Alternatives for controlling floodwater damages are limited, and it is felt that the potential project presented in this report is the most economical and logical method of meeting the needs. Some water storage may be possible in portions of the watershed area draining from Mount Taylor.

Table 1, Structure data, San Mateo-Grants Canyon Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surface area em. spwy. level	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
6	87.2	35	133,000	RC conduit	8	rock	1	420	c
7	72.3	44	59,500	RC conduit	8	RC chute	1	310	c
8	35.2	23	124,900	RC conduit	8	RC chute	1	200	c
9	9.3	49	66,100	RC conduit	8	rock	1	52	c

Table 2, Channel data

Channel designation	Length of reach	Needed channel capacity	Bottom width	Depth	Velocity in channel	Estimated volume of excavation
	(100 ft.)	(cfs)	(ft.)	(ft.)	(ft./sec)	(cu.yds.)
Grants bypass channel	130	4,000	75	6.5	6.9	247,500

Table 3, Reservoir storage capacity, San Mateo-Grants Canyon Watershed

Site	Drainage area	Storage capacity planned: Sediment	Storage capacity planned: Detention	Storage capacity planned: Total
	(sq.mi.)	- - - - acre-feet	- - - - -	
6	87.6	4,230	3,950	8,180
7	72.3	3,080	3,470	6,550
8	35.2	276	1,740	8,016
9	9.3	98	480	576

Table 4, Distribution of structural cost - potential development (dollars) 1/

Structural measures	Installation cost: Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Site 6, Arroyo del Puerto	77,000	43,000	130,000 2/	1,000	251,000
Site 7, San Mateo Creek	231,000	99,000	11,000 3/	1,000	342,000
Site 8, Lobo Canyon	122,000	52,000	500	500	175,000
Site 9, Grants Canyon	53,000	30,000	15,500 4/	500	99,000
Bypass channel	517,000	98,000	221,000 5/	1,000	837,000
Total	1,000,000	322,000	378,000	4,000	1,704,000

1/ Price base: 1969
2/ Includes cost of relocating 2.1 miles of Hwy. 509
3/ Includes cost of altering culvert on Hwy 53
4/ Includes cost of relocating county road
5/ Includes cost of altering drainage structure on I-40

Table 5, Annual cost, San Mateo-Grants Watershed, El Rio en Medio Subbasin

Evaluation unit	Amortization of installation cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
FRS 6	12,340	300	12,640
7	16,820	390	17,210
8	8,600	480	9,080
9	4,870	210	5,080
Ch. imp.	41,160	10,000	51,160
Total	83,790	11,380	95,170

Table 6, Estimated average annual flood damage reduction benefits (dollars) 1/

Item	Estimated average annual damages		Damage reduction benefits
	Without project	With project	
Floodwater			
Agricultural	23,300	4,660	18,640
Urban	73,500	7,340	66,160
Total	96,800	12,000	84,800

1/ Adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits				Av. annual cost	Benefit cost ratio
	Flood prevention damage reduction	Redevelopment	Secondary	Total		
FRS 6, 7, 8, 9 & chan. imp.	84,800	17,200	9,600	111,600	95,170	1.2:1

1/ Adjusted normalized prices

LEGEND

- PAVED HIGHWAY
- SECONDARY ROADS
- UNIMPROVED ROADS
- FLOODWATER RETARD STRUCTURE
- ② SITE NUMBER
- 1-c GOOD RANGE MGT.
- 2-a PINYON-JUNIPER CONTROL
- 2-b PINYON-JUNIPER MGT.
- 4-a SPRUCE-FIR MGT.
- 4-b PONDEROSA PINE MGT.
- 4-c ASPEN MGT.
- 6-a IRRIGATED LAND MGT.
- 7 MISCELLANEOUS LAND
- 8 CRITICAL EROSION AREAS
- PIPELINE
- RAILROAD
- CANAL
- HOUSE
- DRAINAGE PATTERN
- COUNTY BOUNDARY

Scale
2 1 0 1 2 3 4 Miles

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
SAN MATEO-GRANTS WATERSHED
UPPER RIO GRANDE BASIN

SANDIAS WATERSHED

Sandoval and Bernalillo Counties, New Mexico
CNI #1-131

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The watershed is located on the east side of the Rio Grande. The west boundary of the watershed extends about 20 miles along the Rio Grande. The south boundary is about 5.5 miles north of Albuquerque. The north boundary is just south of the Tonque Arroyo. On the east, the boundary extends along the crest of the Sandia Mountains. Bernalillo, located about 18 miles north of Albuquerque, is the largest community within the watershed.

The watershed application covers 84,400 acres, or approximately 132 square miles in Sandoval and Bernalillo Counties. Land status in the watershed is 23,360 acres of National Forest, 36,788 acres of Indian land, 17,808 acres of private land, 5,744 acres of public domain land administered by the Bureau of Land Management and 700 acres of state land.

Of the approximately 22,800 acres of National Forest in the watershed administered by the Sandia Ranger District of the Cibola National Forest, approximately 3,400 acres are classed as commercial forest, 14,800 acres as non-commercial forest, and 4,600 acres as grassland.

There are approximately 4,200 acres of irrigated cropland of which 3,000 acres are Indian land belonging to the Sandia, Santa Ana, and San Felipe Pueblos. Vegetation ranges from grasses and shrubs in the lower elevations to juniper in the foothills, and fir, spruce and pine in the higher elevations.

Numerous arroyos and several canyons flow from the slopes of the Sandia Mountains to the Rio Grande. Since development of the valley area, only one drainage, Las Huertas Creek, has a channel directly into the Rio Grande. Elevations range from 5,000 feet along the Rio Grande to 10,678 feet on Sandia Peak. In the valley area, mean temperatures range from 75 degrees in the summer to 34 degrees in the winter. Average annual precipitation ranges from 9 inches in the valley to about 21.5 inches at the crest of the Sandia Mountains. The watershed is within the Four Corners Economic Development Region.

SCS PHOTO 12-P1020-3

Urban damage area. Fence still retains trash from last year's high water

SCS PHOTO 12-P1020-4

Watershed Problems and Needs

Most of the arroyos entering the Rio Grande from the Sandia Mountains carry floods to the valley which damage homes, businesses, roads, streets, bridges, irrigated farmland, irrigation canals, other irrigation facilities, and farm equipment. The Atchison, Topeka, and Santa Fe Railroad has received damage from floodwater and sediment.

Damaging storms occurred in 1949, 1951, 1955, 1956, 1963, and 1967, as remembered by the local people. It was reported that the 1949 storm caused $100,000 damage in Bernalillo. The 1956 storm caused about $20,000 damage and the 1967 storm did about $139,000 damage. It is estimated that the 1956 storm was about a five-year storm and the 1967 storm about a ten-year storm.

Irrigation water management measures are needed for more efficient water use, and 420 acres need subsurface drainage. Permanent water storage is needed for recreational purposes to satisfy the population in the vicinity of Albuquerque. About 8 percent of the watershed is critically eroded.

Physical Potential for Meeting Needs

The average annual precipitation in the lower elevations is about 9 inches and the evaporation rate is high; therefore, permanent storage in structures controlling these areas is not considered feasible for recreation or other uses. The drainage areas of the Las Huertas and the Sandia Wash include areas in the Sandia Mountains which have an average annual precipitation ranging up to 30 inches. Possibly, permanent storage can be provided in structures in the upper portion of these two drainages for recreation, municipal, and industrial use. As these two structures would be located a significant distance upstream, limited floodwater control could be realized from them.

Soil, climatic, and topographic conditions team up in the lower elevations of this watershed to make land treatment difficult and expensive but not impossible. Due to the low precipitation, topography, and cover, land treatment alone would not meet the desired level of protection needs.

Soils are moderately deep to deep over most of the area, but are unstable and subject to severe sheet and gully erosion when vegetative cover is disturbed or depleted.

The topography of the lower elevations of the watershed lends itself to the installation of floodwater retarding structures. Soil material at all potential structure sites is rated as adequate and fair for construction. Surface investigations of the foundations and abutments were made at the structure site locations. The sites are located in the Santa Fe Geologic Group and will present no problems for installation and maintenance of the structures. Detailed investigations on foundations and abutments will

be made before design. Channel stability analysis will be made during planning of this project.

Outlet works for the structures would present a problem as none of the arroyos on which structures are economically feasible have channels to the Rio Grande. There are several alternative routes for planning outlet channels for the principal spillway flows. The most logical and economical alternative is to utilize existing irrigation systems, thereby accomplishing dual purposes, agricultural water management and flood prevention. This can be done by outleting several principal spillway flows into an irrigation canal and carrying the flow to a point where it can be channeled to the river. This will require lining portions of the irrigation canal.

Local Interest in Project Development

In January of 1963, the local people submitted a watershed application for assistance under Public Law 566 for flood protection. In August, 1963, a preliminary investigation was made on the watershed. At that time, historical information on flood damages was limited and the cost-benefit ratio was not favorable. The investigating personnel felt that a more detailed investigation should be made, and the application should be amended to include the area to the south of the original boundaries. The local people submitted the amendment in January of 1964. The sponsors of the application are the Sandoval Soil and Water Conservation District, Bernalillo and Sandoval County Commissioners and Sandia, Santa Ana, and San Felipe Pueblos. The watershed has been authorized for planning under the Public Law 566 program.

A damaging flood occurring in 1967 revived the interest of the local people to such a degree that they demanded something be done.

The local people are mainly interested in protection from floodwater, but there are other considerations such as the lining of irrigation canals. There is also some interest in permanent water storage for recreation, municipal, and industrial purposes.

The community of Placitas expressed a need and desire to develop a permanent water storage on the upper portion of the Las Huertas Arroyo for municipal, industrial, and recreation uses. There is also interest for development of a recreation pool in the upper reaches of the Sandia Wash (Juan Tabo Canyon).

Financing the recreational, municipal, and industrial water storage may be a problem. The local people must meet collectively to decide whether or not the inclusion of agricultural water management, recreation, municipal, and industrial uses as additional purposes along with flood prevention is desirable. If so, they must also determine how the project could be financed. Financial assistance is available from several different sources both state and federal.

Should the local people decide to include the additional purposes, the application should be amended to include them.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Because of the location and heavy recreation use in this area, special emphasis is made upon intensified fire protection, particularly in the higher elevations. Where land treatment measures are planned, adjacent to or near recreational developments either existing or planned, they should blend harmoniously with the landscape.

Systems include:

(a) Good range management on 31,600 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 2,400 acres of grazable woodland.

(c) Oakbrush control on 120 acres of brushland.

(d) Good spruce fir management on 4,320 acres of commercial timberland.

(e) Good management of ponderosa pine on 2,100 acres of commercial timberland.

(f) Phreatophyte control on 3,200 acres of bottomland.

(g) Effective drainage on 420 acres of irrigated land.

(h) Improved irrigation systems on 3,440 acres of irrigated land.

(i) Erosion control on 7,200 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in areas of heavy use near farmsteads and urban areas. Effective methods that may be used on eroded land are small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation. Severely eroded areas can also utilize mechanical and vegetative treatment as exemplified by the Bernalillo Pilot watershed project.

The National Forest project work inventory lists nonrecurrent work needed on the watershed. This work includes land treatment for erosion control; vegetative manipulation for improving water yield and range conditions; and timber stand improvement for improved and/or increased yield of wood products. These projects are desirable and will be considered for including in the Public Law 566 project work plan.

Structural Measures

A reconnaissance of the watershed was made. It was determined that 17 potential floodwater retarding structures, one floodwater diversion, and associated outlet channels and improvements will afford a desired level of protection. The dams and reservoirs are planned as single purpose flood control structures.

The principal spillway discharge from sites 1 and 3 will be combined with the flow from sites 2, 2A and 3A in an existing channel to the Rio Grande. The outlet for site 4 will be concrete-lined channel to Las Huertas Creek and to the river. The flow from sites 7, 8, 10, 11, 12, and the flow from site 1 of the Bernalillo pilot project can be discharged into the San Felipe Acequia, the Bernalillo ditch, and the Sandia Acequia.

All channels from the potential structures to the canal will be concrete-lined. The main outlet channel will be the irrigation canal, resized and lined with concrete to allow the flood flow to be discharged without damage to the irrigation system. The outlet to the Bernalillo interior drain will be at site 15 where the flows from site 15 and 16 can be combined with the canal flow and passed under the railroad at an existing crossing. The discharge from site 17, 18, and 19 will be discharged into the canal and conveyed to the river through the existing flood channel constructed by the Corps of Engineers.

The potential structural measures and the completed structure on the Bernalillo pilot project control 86 square miles, or about 66 percent of the watershed.

Channel 000 could be discharged into the flow from site 1 of the Sandia Mountains Watershed project into the main outlet channel for the watershed.

Nature and Estimate of Costs of Improvements

Investigations consisted of field reconnaissance and use of U. S. Geological Survey 1:24,000 scale quadrangles. Site conditions are such that no unusual design or construction problems are anticipated; however, several of the sites may have gravel in the abutments. As outlet channels from the potential retarding structures to the main channel will be in highly erosive material, concrete lining is planned.

Major items of work include earthfill for the 17 potential floodwater retarding structures, concrete to line the outlet channels, and reinforced concrete for the construction of 3 bridges to private holdings and a bridge on U. S. Highway 85 on channel 10,000.

The land area where the potential structures are located is all rangeland. There should be no problems in acquiring easements. It is not anticipated that any utility lines would need to be relocated but a section of Highway 85 might have to be modified.

The estimated costs of the earthfill structures was obtained by estimating the fill required to build the necessary size of dam and then applying a unit cost to the fill volume. The unit cost per cubic yard was obtained from a curve developed from quantities and costs of structures planned for Public Law 566 projects. These cost data were updated to 1969 prices. The cost of concrete was determined by preparing a preliminary design and estimate of quantities and then applying the current prices to the quantities. Land easements costs are estimated to be relatively small due to the fact that much of it is Indian land or public domain and the canal proposed for the main outlet channel has an adequate easement and location. Twenty percent contingencies have been added to the estimated construction cost to cover unforeseeable expenses. Installation services are estimated to be about 43 percent of the total construction cost.

Effect and Feasibility of Potential Development

Floodwater damages in this watershed occur to crops, pasture,urban properties, irrigation services, roads and bridges. Average annual flood damage without the project is estimated to be $255,500. With the project measures installed, damages would be reduced to $28,500 (an 88 percent reduction). The resulting average annual damage reduction benefits would be $227,000.

Other project benefits would result from redevelopment and secondary sources. Redevelopment benefits are estimated to be $61,700 and secondary benefits $31,900. Average annual project benefits are estimated to be $320,600 and the average annual cost of the structural measures is estimated to be $295,560. This results in a benefit-cost ratio of 1.1 to 1.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization. Total average annual cost for the land treatment systems is estimated to be $162,200. The average annual return is estimated to be $568,600.

Alternate or Additional Possiblities

There may be several additional sites where a feasible floodwater retarding structure can be constructed. These sites should be examined in detail in planning. A more advantageous site for site 5 which may be available a short distance downstream should be examined. There are several alternate ways and routes for the discharge from the principal spillways to be carried to the Rio Grande. The channels could be taken directly to the river across the valley floor. Other combinations of discharge and routes across the valley to the river may be used, or there is the possibility of using channels with control structures in an unlined channel.

Additional water management and irrigation system development is a possibility and there is a definite need for this development. These possibilities were not considered in the report but should be investigated when a firm project plan is being developed.

Table 1, Structure Data, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surf. area em. spwy level	Structure class
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yd.)		(csm)			(acres)	
1	6.0	35	129,475	RC conduit	10	RC chute	1	57	c
2	2.8	31	70,360	RC conduit	20	RC chute	1	35	c
2a	2.7	35	100,000	RC conduit	20	RC chute	1	36	c
3a	2.4	42	111,160	RC conduit	20	RC chute	1	27	c
3	0.4	22	23,080	RC conduit	20	RC chute	1	4	c
4	1.5	41	73,060	RC conduit	20	RC chute	1	16	c
5	26.1	105	844,970	RC conduit	8	RC chute	1	100	c
7	5.7	45	201,700	RC conduit	10	RC chute	1	42	c
8	4.9	40	250,240	RC conduit	10	RC chute	1	39	c
10	1.3	45	79,440	RC conduit	10	RC chute	1	14	c
11	3.9	58	164,500	RC conduit	10	RC chute	1	18	c
12	0.9	35	90,905	RC conduit	20	RC chute	1	14	c
15	14.7	45	238,382	RC conduit	8	RC chute	1	80	c
16	1.3	24	48,450	RC conduit	20	RC chute	1	15	c
17a	1.4	32	95,130	RC conduit	20	RC chute	1	13	c
18	3.5	38	287,340	RC conduit	15	RC chute	1	24	c
19	2.5	30	146,030	RC conduit	20	RC chute	1	17	c

Table 2, Channel data, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach (100 ft.)	Watershed area (sq.mi.)	Needed channel capacity (cfs)	Bottom width (ft.)	Depth (ft.)	Velocity in channel (ft./sec.)	Estimated volume of excavation (cu.yds.)
Channel 100	50	6.0	120	20	2	3	7,400
Channel 300	30	0.4	30	10	2	3	1,120
Channel 400	60	1.5	40	2	3	4	conc. lined
Channel 700	42	5.7	60	2	3	12	conc. lined
Channel 800	25	4.9	50	2	3	13	conc. lined
Channel 000 from site 1 Sandia Mts. Watershed	35	4.1	75	2	3.8	15	conc. lined
Channel 1000	20	1.3	20	2	1.8	6	conc. lined
Channel 1100	24	3.9	40	2	2.8	6	conc. lined
Channel 1200	17	0.9	20	2	1.8	6	conc. lined
Channel 1500	49	14.7	120	4	2.7	15	conc. lined
Channel 1600	70	1.3	30	2	1.5	4	conc. lined
Channel 1700	43	1.4	50	2	2	15	conc. lined
Channel 1800	6	3.5	50	2	2.5	15	conc. lined
Channel 1900	10	2.5	50	2	2.5	15	conc. lined
Channel 10,000 composite for sites 7, 8, 10, 11 12, & 1, Sandia Mts. WS	333	--	300	4	5.5	7	conc. lined
Channel 20,000 composite for sites 18 & 19	68	--	170	3	4.5	6	conc. lined
Channel 30,000 from channel 10,000 to drain	17	--	450	6	6.0	5	conc. lined

Table 3, Reservoir storage capacity, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Storage capacity planned: Sediment	Detention	Total
	(sq.mi.)	- - - - - - - - acre-feet	- - - - - - - -	- - - - - - - -
1	6.0	437	371	808
2	2.8	246	172	418
2a	2.7	216	168	384
3a	2.4	217	149	366
3	0.4	46	24	70
4	1.5	146	94	240
5	26.1	1,682	1,625	3,307
7	5.7	329	353	792
8	4.9	205	304	509
10	1.3	102	80	182
11	3.9	113	249	362
12	0.9	77	55	132
15	14.7	375	910	1,285
16	1.3	26	82	108
17a	1.4	25	84	109
18	3.5	104	218	322
19	2.5	51	156	207

Table 4, Distribution of structural cost - potential development, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Evaluation Unit 1					
Floodwater retarding structure, Site 1	130,700	55,600	1,400	300	188,000
Outlet channel 100	6,200	2,700	500	300	9,700
Subtotal	136,900	58,300	1,900	600	197,700
Evaluation Unit 2					
Floodwater retarding structure, site 2	84,000	36,300	1,000	300	121,600
site 2A	99,000	42,700	1,000	300	143,000
Site 3A	111,000	48,000	700	300	160,000
Subtotal	294,000	127,000	2,700	900	424,600
Evaluation Unit 3					
Floodwater Retarding structure, site 3	50,000	21,000	500	500	72,000
site 4	97,000	42,000	500	500	140,000
Outlet channel 300	2,000	1,000	500	500	4,000
400	32,000	12,000	500	500	45,000
Subtotal	181,000	76,000	2,000	2,000	261,000
Evaluation Unit 4					
Floodwater retarding structure, site 5	1,025,000	442,000	1,500	500	1,469,000

Table 4, Distribution of Structural cost - potential development, Sandias Watershed (continued)

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Evaluation unit 5					
Floodwater retarding structure, Site 7	217,000	93,500	1,000	500	312,000
Channel 700	25,700	11,000	500	500	37,700
1/6 part of main outlet channel	57,700	24,700	500	500	83,400
1/8 part of channel to drain	13,600	5,800	500	-	19,900
Subtotal	314,000	135,000	2,500	1,500	453,000
Evaluation unit 6					
Floodwater retarding structure, site 8	228,000	98,000	500	500	327,000
site 10	94,000	40,000	500	500	135,000
site 11	190,000	82,000	500	500	273,000
site 12	93,000	40,000	500	500	134,000
Channel 800	15,000	6,000	500	500	22,000
Channel 000	23,000	10,000	500	500	34,000
Channel 1000	10,000	4,000	500	500	15,000
Channel 1100	13,000	5,000	500	500	19,000
Channel 1200	8,000	3,000	500	500	12,000
5/6 of main channel	289,000	123,000	2,000	1,000	415,000
5/8 part of channel to drain	68,000	29,000	500	500	98,000
Subtotal	1,031,000	440,000	7,000	6,000	1,484,000

Table 4, Distribution of structural cost - potential development, Sandias Watershed (continued)

	Installation cost				
Structural measures	Construction	Installation services	Land, easements and RW	Administration of contracts	Installation cost
Evaluation unit 8					
Floodwater retarding structure, site 15	231,000	100,500	2,000	500	334,000
Channel 1500	33,000	14,000	500	500	48,000
1/8 part channel to drain	14,000	6,000	500	500	21,000
Subtotal	278,000	120,500	3,000	1,500	403,000
Evaluation unit 9					
Floodwater retarding structure, site 16	64,000	25,000	500	500	90,000
site 17a	90,000	39,000	500	500	130,000
Floodwater diversion 1	77,000	32,000	500	500	110,000
Channel 1600	36,000	15,000	500	500	52,000
Channel 1700	67,000	22,000	500	500	90,000
1/8 part channel to drain	14,000	6,000	500	500	21,000
Subtotal	348,000	139,000	3,000	3,000	493,000

Table 4, Distribution of structural cost - potential development, Sandias Watershed (continued)

Structural measures	Installation cost: Construction	Installation cost: Installation services	Installation cost: Land, easements and RW	Installation cost: Administration of contracts	Installation cost
Evaluation unit 10					
Floodwater retarding					
structure site 18	200,000	86,000	500	500	287,000
Site 19	122,000	52,000	500	500	175,000
Channels	139,000	59,000	3,000	---	201,000
Subtotal	461,000	197,000	4,000	1,000	663,000
TOTAL ALL UNITS	4,068,900	1,734,800	27,600	17,000	5,848,300

1/ Price base: 1969

Table 5, Estimated average annual flood damage reduction benefits, Sandias Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater			
Crop and pasture	43,200	4,300	38,900
Urban	150,650	15,050	135,600
Interrupted irrig. service	17,900	1,800	16,100
Subtotal	211,750	21,150	190,600
Roads and bridges	20,500	2,000	18,500
Indirect	23,250	5,350	17,900
Total	255,500	28,500	227,000

1/ Based on adjusted normalized prices

Table 6, Annual cost, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost (dollars) 1/	O & M cost (dollars) 2/	Total annual cost
FRS 1 and channel improvement	9,720	250	9,970
FRS 2, 2a, 3a, and channel improvement	20,880	600	21,480
FRS 3, 4, and channel improvement	12,830	350	13,180
FRS 5	72,230	2,000	74,230
FRS 7 and channel improvement	22,270	600	22,870
FRS 8, 10, 11, 12, and channel improvement	72,970	2,050	75,020
FRS 15 and channel improvement	19,820	550	20,370
FRS 16, 17, and channel improvement	24,240	700	24,940
FRS 18, 19, and channel improvement	32,600	900	33,500
Total	287,560	8,000	295,560

1/ Amortized for 100 years at 4 7/8 percent interest

2/ Adjusted normalized prices.

Table 7, Comparison of benefits and costs for structural measures, Sandias Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Evaluation unit	Average annual benefits: Flood prev. damage red.	Average annual benefits: Redevelopment	Average annual benefits: Secondary	Average annual benefits: Total	Average annual cost	Benefit-cost ratio
FRS 1 and channel improvement	21,092	2,100	3,475	26,667	9,970	2.7:1
FRS 2 and channel improvement	13,312	4,550	1,890	19,752	21,480	0.9:1
FRS 3, 4, and channel improvement	9,812	2,750	1,550	14,112	13,180	1.1:1
FRS 5	8,177	15,390	1,460	25,027	74,230	0.3:1
FRS 7 and channel improvement	13,083	4,760	2,075	19,918	22,870	0.9:1
FRS 8, 10, 11, 12, and channel improvement	79,560	15,650	9,240	104,450	75,020	1.4:1
FRS 15 and channel improvement	40,883	4,220	6,350	51,453	20,370	2.5:1
FRS 16, 17, and channel improvement	26,363	5,280	3,500	35,143	24,940	1.4:1
FRS 18, 19, and channel improvement	14,718	7,000	2,360	24,078	33,500	0.7:1
Total	227,000	61,700	31,900	320,600	295,560	1.1:1

1/ Adjusted normalized prices

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
SANDIAS WATERSHED
UPPER RIO GRANDE BASIN

BELEN-LOS LUNAS WATERSHED

Valencia County, New Mexico
CNI #1-116

WATERSHED INVESTIGATION REPORT

The Watershed in Brief

The Belen-Los Lunas Watershed is located in Valencia County of central New Mexico. The boundaries of the watershed are: the Isleta Indian Pueblo Reservation boundary on the north, the Belen Mesa on the west, approximately the Valencia-Socorro County line on the south, and the Rio Grande on the east.

The watershed covers an area of about 109 square miles (69,670 acres). Approximately 21,000 acres of irrigated cropland are in the watershed; the remainder is rangeland and miscellaneous uses.

The town of Belen and the village of Los Lunas are within the watershed. Highways I-25 and U. S. Highway 85 and the Santa Fe railway traverse the watershed north to south. State Highway 6 crosses the watershed at Los Lunas.

The irrigated lands are all served by the Middle Rio Grande Conservancy ditches.

Watershed Problems and Needs

Major problems are floodwater and sediment damages to canals, irrigated cropland, roads, the railroad, and to the towns and businesses in the watershed. The main irrigation distribution canals are operated and maintained by the Middle Rio Grande Conservancy District and are generally adequate; however, there is a great need for improvement of "on-farm" irrigation ditches, fields, and water control structures.

From a consideration of flood control the watershed needs (1) structural measures to retard the flow of floodwater and store the sediment before it reaches the developed area; (2) controlled outlet channels to discharge the reduced flood flow to the river, and (3) proper range use in the watershed above the structural control measures; and (4) on-farm agricultural water management practices to be installed.

Physical Potential for Meeting Needs

Good dam and reservoir sites are not generally available; however, the required storage capacity can be obtained by constructing "horseshoe-

Looking east from irrigation canal bank that broke during storm in June 1969 SCS PHOTO

shaped" or dog-legged" dams. With this type of construction, physical conditions of site and geologic formations and fill are suitable to construct needed structural measures.

Local Interest in Project Development

For several years the local residents of the watershed have been aware of the needed measures to protect them from flood damage. In April 1958, an application for assistance under Public Law 566 was submitted with the East Valencia Soil and Water Conservation District as sponsor. Since then, the town of Belen, the village of Los Lunas, and the Valencia County Commissioners have become co-sponsors of the project.

In March 1964 a preliminary investigation of the watershed was conducted by the watershed planning staff of the Soil Conservation Service. This investigation showed that a physically and economically feasible project can be developed and installed. Recommendations were made and authorization for planning under Public Law 566 was issued on Feburary 12, 1968.

A severe storm and damaging flood in Belen in June 1969 created a greater awareness of the need and the local people are anxious to get the project planned and installed.

Nature and Estimate of Cost of Improvements

Inasmuch as the watershed is authorized for planning under Public Law 566 and planning for flood control works is in progress, estimates of structure data and costs for installation have not been made and will not be a part of this report.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Good range management on 20,736 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Control of 512 acres of mesquite.

(c) Phreatophyte control on 1,280 acres of land.

(d) Effective drainage systems on 5,000 acres of land.

(e) Improved irrigation facilities on 12,000 acres of irrigated land.

(f) Good management of 1,012 acres of abandoned cropland.

(g) Erosion control on 4,608 acres of critically eroded land.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $82,400. The average annual return is estimated to be $300,000.

Removing sediment from Main Street in Belen, New Mexico, June 1969
SCS PHOTO

Pumping floodwater from basement in downtown Belen, New Mexico, June 1969
SCS PHOTO

Structural Measures

During conduct of the preliminary investigation, it was estimated that eight small floodwater retarding structures and five small floodwater diversions would provide adequate protection to the area. In 1968, the United States Bureau of Reclamation constructed a small flood control structure in one of the proposed sites (Houston Arroyo).

Since the preliminary investigation was conducted in 1964, damage has continued to occur from floods. From preliminary evaluation of the storm and flood patterns along with the flood-damaged area, it has been concluded that the original proposal for a project is inadequate to provide the required level of protection.

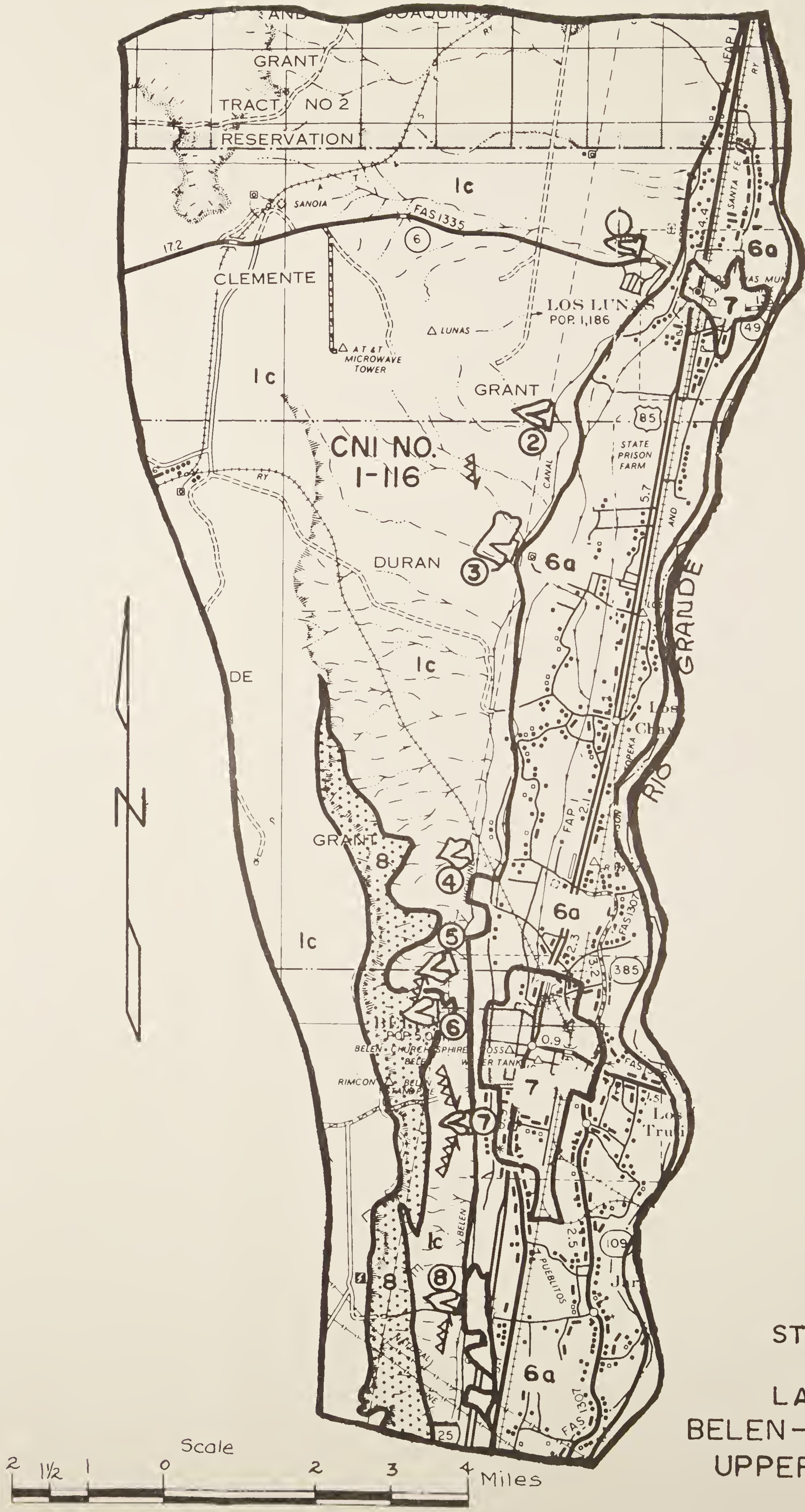
It is recommended that the project consist of four long dams to control all of the small arroyos contributing floodwater and sediment and one floodwater diversion above Interstate Highway 25 currently being constructed. A controlled outlet channel for the principal spillway discharge will need to be provided to discharge the flow into the Riverside drain. Tentative locations for the proposed structures are shown on the attached map.

Alternate or Additional Possibilities

A system of collecting diversions with a controlled channel from the flood source of the river is a possible solution to the flood problem. However, this approach would require several long channels crossing high-value lands and improvements. It is felt that this solution would be more expensive and not provide the desired level of protection when compared to the proposed floodwater retarding structures.

LEGEND

- COUNTY BOUNDARY
- HOUSE
- DRAINAGE PATTERN
- PROPOSED FLOODWATER RETARD STRUCTURE
- FLOODWATER DIVERSION
- 1c GOOD RANGE MGT.
- 3a1 SAGEBRUSH CONTROL
- 5 BOTTOMLAND VEGETATION MGT.
- 6a IRRIGATED LAND MGT.
- 7 MISCELLANEOUS LAND
- 8 CRITICAL EROSION AREA
- DIVIDED HIGHWAY
- PAVED HIGHWAY
- UNIMPROVED ROADS
- SECONDARY ROADS
- RAILROAD
- CANAL
- PIPELINE
- BRIDGE
- TOWN



STRUCTURE LOCATION
AND
LAND TREATMENT MAP
BELEN-LOS LUNAS WATERSHED
UPPER RIO GRANDE BASIN

CORRALES WATERSHED

Bernalillo and Sandoval Counties, New Mexico
CNI #1-130

SUMMARY OF THE WORK PLAN

The Watershed in Brief

The Corrales Watershed is located west of the Rio Grande in Sandoval and Bernalillo Counties, New Mexico. The community of Corrales, located approximately 10 miles north of downtown Albuquerque, is in the downstream portion of the watershed. The watershed covers an area of 85.5 square miles or 54,720 acres. The streamflow is in the southeast direction off of the Rio Puerco-Rio Grande divide to the Rio Grande valley.

Sea level elevations range from 6702 feet at the divide to 4985 feet at the bottom of the Corrales-Riverside drain.

Geologic formations in the watershed are the Santa Fe Group composed of unconsolidated red-grey and green clays and silts, pediment gravels and sands, Tertiary and Quaternary age alluvium.

The watershed is in the southern desertic basin plains and mountain land resource area of New Mexico. Soils are shallow and moderately deep, sandy textured, and some places contain fine to coarse gravel with varying amounts of caliche. Soils of the Rio Grande floodplain are generally deep and sandy to fine-textured.

All of the cropland is irrigated and is situated on the floodplain of the Rio Grande. Agricultural land not classed as cropland is rangeland used for grazing. An area of about 15,500 acres in the lower portion of the watershed has been excluded from grazing and is being subdivided into one-half and one acre lots for housing developments. All of the irrigated land is within the floodplain of the Rio Grande between the Corrales main canal and the Rio Grande. The system of levees constructed by the Army Corps of Engineers provides flood protection on the floodplain lands from floods on the Rio Grande.

Vegetation consists of juniper, yucca, Russian thistle, snakeweed and Mormon tea. Principal grasses in the watershed are galleta, blue grama, black grama, and Indian rice grass. Much of the land use in this watershed has changed from range to urban-suburban which has brought about livestock exclusion resulting in increased grass cover and overall protection for the watershed. There has also been an improvement in vegetation in the lower portion of the watershed. Twenty-seven percent of the watershed is producing sagebrush, but, due to eminent urbanization of the area, no sagebrush needs control. Most of the grassland has been retired from grazing use and is receiving good management. The grasslands are in better condition than they have been for many years.

The Corrales Watershed is in the semi-arid climatic zone. Average annual precipitation is 7.5 inches. About one-half of this rainfall occurs in the late summer from convective-type storms. Most flood-producing storms are of high-intensity and short-duration rainfall covering an average area of about 20 to 30 square miles. The average annual temperature is 56.9°F. About 49,730 acres are privately-owned, 3,050 acres are state land, 1,750 acres are federally-owned land, and 190 acres are Indian land.

Land use break down within the watershed is 27,748 acres of rangeland 2,070 acres of irrigated cropland, and about 24,902 acres of miscellaneous use. The watershed is located in the Four-Corners Development Area.

Problems and Needs

The arroyos in the watershed flow into the Rio Grande Valley and damage irrigation facilities of the Middle Rio Grande Conservancy District, irrigated land, crops, roads, residential property, farm irrigation facilities, and other farm improvements.

Historical information indicates that damaging floods have occurred on the average of about once every 15 years. Damaging floods occurred in 1904, 1919, 1921, 1929, and 1941. All of these floods occurred during the summer and early fall months from July to September resulting in heavy damage to crops. In 1941 approximately 400 acres of irrigated land were flooded. The Corrales Main Canaland State Road 46 were damaged and several homes flooded. The estimated damage in 1941 was about $40,000 and, with the present development, a flood of the same magnitude would now cause considerably more damage.

The 400 acres of irrigated land flooded in 1941 were in alfalfa, orchards, vineyards, corn, vegetables, and home gardens. The estimated crop damage in 1941 was $16,000 (1941 prices). Some areas in irrigated cropland in 1941 are now in residential use. One area which was in alfalfa in 1941 was flooded to a depth of 3 feet. This area is now occupied by 25 homes. Residential damage in 1941 was approximately $5,000.

Damage to fences, farm irrigation systems, farm buildings, farm equipment and other farm improvements was estimated to be $7,100 based on 1941 prices. Flood damage to the Middle Rio Grande Conservancy District irrigation facilities was $5,960, and delivery of irrigation water was interrupted for several days. Estimated road damage was $3,000 (1941 price levels). Estimated indirect damage in 1941 was about 10 percent of the direct damage, or $3,600.

Flood damage to crops includes actual loss of crops as well as lowering of the quality and grades of the crops. Vegetable crops are particularly susceptible to damage even from depths of flooding less than one foot. Damage to irrigation facilities causes reductions in crop yields by interruption of irrigation service.

Channel erosion on the Arroyo de Los Montoyas above the Corrales area from 1960 flood. SCS PHOTO

Farmsteads, farm buildings, other farm improvements and farm equipment are damaged by floods in the watershed. Floods damage State Road 46, county and private roads and cause delays in travel by residents to jobs, schools, and markets.

The estimated average annual floodwater damage in the watershed under future conditions without the project is $54,968.

Deposition of sediment in the Corrales Main Canal and irrigation drains necessitates additional maintenance to remove the sediment. The deposition of sediment plugs up the canal, causing floodwater and irrigation water in the canal to overflow. Sediment deposition on irrigated land covers up crops and also lowers the quality or grades. Sediment damage to crops is estimated to be 10 percent of the floodwater damage to crops.

Sediment is also deposited on lawns and inside homes causing substantial damage. Sediment damage is estimated to be about 20 percent of the floodwater damage to residential property.

The average annual damage from sediment is estimated to be $12,280 under future development without the project.

Erosion is occurring on rangeland in the upland portion of the watershed. Streambank erosion is minor and is active only along scattered sections

of the channel. The primary source of sediment is sheet erosion. Erosion of roads is active where newly bladed roads have been established. These roads will actively erode until the area is more fully developed and surfaced roads are provided.

No significant erosion damage occurs in the damage area. Minor scouring occurs when floods overtop the Corrales Main Canal. These damages have been included under floodwater damage.

Cultivated land comprises 4 percent of the watershed of which 1,380 acres need irrigation systems.

Approximately 1,000 acres (in small tracts) in the watershed have critical erosion problems. Land treatment measures to stabilize erosion on the rangeland portion of the watershed are needed. Roads need to be paved to prevent gullies from developing and residential areas need to be planned to provide sufficient surface water drainage.

Flood prevention measures are needed to obtain the necessary degree of flood protection.

Physical Potential for Meeting Needs

A low average annual precipitation makes permanent storage for any purpose impractical.

Soil, climatic, and topographic conditions team up in the lower elevations of this watershed to make land treatment difficult and expensive but not impossible.

Topography of each one of the arroyos is such that numerous possible structure site locations are available; but, due to sub-dividing and development of residential areas within the lower portion of the watershed, all but one structure were considered impractical. Topography within the lower reaches of the watershed is such that two diversions can be installed to protect the area below. The slope and soils make it impossible to put in an earth channel; therefore, concrete-lined channels were developed to convey water into the Rio Grande Channel.

Adequate irrigation and drainage facilities are operated and maintained by the Middle Rio Grande Conservancy District which receives aid from the Bureau of Reclamation. The potential project would provide a high degree of protection to the irrigated land and irrigation facilities.

Local Interest in Project Development

The sponsoring local organizations are the Central Rio Grande Soil and Water Conservation District, the Corrales Watershed District, and the Sandoval Soil and Water Conservation District. The work plan on the Corrales Watershed has been completed and since then the sponsoring local

organization has obtained much of the land easements and rights-of-way needed for the installation of the structural measures. The project was authorized for construction June 1970.

Works of Improvement for Potential Development

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(1) Good range management on 40 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(2) Improved irrigation facilities on 1,380 acres of irrigated land.

(3) Erosion control on 960 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils, and in heavily used areas near farmsteads and urban areas. Effective methods for erosion control include small gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

Structural Measures

The structural measures planned would meet the sponsors' objectives for needed flood prevention. Alternate measures to provide the same level of protection were studied and analyzed to determine the most economical and feasible means of accomplishing project objectives.

Investigations were made by representatives of the local sponsoring organizations and the Soil Conservation Service to determine watershed problems and possible solutions.

In selecting sites for structural measures,consideration was given to those structures which would provide the maximum protection from floodwater and sediment damage.

Control of the watershed by floodwater retarding structures and their outlet channels was considered. It was determined that a system comprising one floodwater retarding structure and two floodwater diversions would meet the project objectives by providing the desired level of protection at least cost.

Structural measures with appurtenances to be installed include one floodwater retarding structure (site 2), two floodwater diversions 1 and 2, one stream channel improvement, and modification of existing irrigation facilities. The structural measures will control runoff from 70.6 square miles which is 82 percent of the total watershed area. The project map shows the location of the structures.

Site 2 is a single purpose structure for flood prevention and is located on Arroyo de los Montoyas in sections 34 and 35, range 2 east, township 13 north. It will control 1.43 inches of runoff from 36.8 square miles which is 43 percent of the total watershed area.

Floodwater diversion 1 will divert floodwater and sediment from the uncontrolled area of Arroyo de los Montoyas, Las Lomatas Negras Arroyo, and the area between them, and the principal spillway discharge from site 2 into the Rio Grande. It is approximately 11,610 feet long and has a rectangular reinforced concrete channel.

Floodwater diversion 2 will convey floodwater and sediment from Black's Arroyo into Arroyo de las Calabacillas. It will be approximately 5,342 feet long, consisting of about 1,131 feet of collecting dike and 4,211 feet of rectangular reinforced concrete channel section.

The plan provides for channel improvement on the lower end of Arroyo de las Calabacillas which is included in the project area. The lower end of the existing arroyo channel will be used as an outlet for floodwater diversion 2 into the Rio Grande.

Nature and Estimate of Costs of Improvements

The total installation cost of structural measures includes cost of construction, installation services, land rights, and contract administration. The construction cost of structural measures included in the plan is the estimated cost of construction plus a 12 percent allowance for contingency. Unit costs are based on 1967 costs.

Estimated construction cost for site 2 is $462,725. This includes $281,298 for the earthfill embankment, $138,377 for the emergency spillway, a cost of $20,384 for the principal spillway, $5,936 for the impact basin, $3,872 for the turning dike, and $12,858 for seeding grass on borrow areas and the structure.

The construction cost for floodwater diversion 1 is estimated to be $1,101,851. This cost includes $76,738 for excavation and earthfill; $943,309 for approximately 11,610 feet of reinforced concrete channel; $9,584 for structure 101 for drainage area "a"; $22,160 for structure 102 for drainage area "b" and "c"; and $10,164 for structure 105, the inlet structure for drainage area "d"; $9,018 for concrete box culvert in the Corrales Main Canal, structure 106; $9,959 for the seeding of disturbed areas to grass; and $20,919 for structure 103, the inlet for Arroyo Lomatas Negras.

Estimated construction cost for floodwater diversion 2 is $502,480. This cost includes the following items: $43,524 for excavation and earthfill, $390,087 for approximately 4,211 feet of reinforced concrete channel; $26,880 for riprapping 1,130 feet of collecting dike; $35,463 cost of concrete chute spillway structure 202; and $6,526 for seeding disturbed areas and embankment to grass.

The estimated construction cost for stream channel improvement on the lower end of Arroyo de las Calabacillas is $10,491. This cost includes $1,867 needed to raise the levees three feet for a distance of 400 feet upstream from the Rio Grande levee and $8,624 for approximately 1,200 cubic yards of riprap needed to protect a portion of the levee on the arroyo.

Modification of existing irrigation facilities which cross arroyo de las Calabacillas will be required. Estimated construction cost of raising the head walls on Corrales Main Canal is $3,920, and construction cost for extending pipe culverts on Lower Riverside Drain is $1,120.

The estimated construction cost of the structural measures in the plan is $2,082,587, of which $2,075,558 will be paid with Public Law 566 funds and $7,029 by other funds.

Installation services include cost of engineering services for surveys, investigaitons, design, preparation of plans and specifications, and inspection during construction, and other administrative and technical assistance. Engineering services include the cost of the geologists' time in making site investigations.

Engineering services were estimated to be 15 percent of the construction cost on site 2 and the two floodwater diversions. The cost of engineering services on stream channel improvement and modification of irrigation facilities was estimated to be 25 percent of the construction cost. The estimated cost of engineering services is $309,540 for all structural measures.

Other installation services include all administrative overhead and direct cost for services provided by persons other than engineers and geologists. The estimated cost of installation services by persons other than engineers and geologists is $110,376. Total installation services cost for the installation of the potential structural measures included in the plan is $419,916. Land rights cost includes all cost associated with acquiring land or access to land, flood easements, flowage easements, land rights surveys, bridges, and modification of utilities. Land, easements, and rights-of-way costs are estimated to be $103,165, flowage and flood easements $25,175, bridges $15,270, modification of a natural gas line $1,200, and land rights surveys $1,500.

The land rights required for construction include 343 acres for site 2, 35 acres for floodwater diversion 1, and 23 acres for floodwater diversion

2. Flowage and flood easements required include 202 acres for site 2, 35 acres for floodwater diversion 1, and 9 acres for floodwater diversion 2.

Administration of contracts includes all costs for administration, legal and clerical services incurred by the contracting local organization in awarding and carrying out contracts for the potential structural works. The estimated cost of contract administration is $2,900.

All costs for construction and installation are based on field surveys and preliminary designs for structural measures. These cost estimates were completed for the Public Law 566 watershed work plan.

This work plan includes structural measures which are considered feasible and have been proven, in the planning process, to be the most economical program to provide the protection needed in the flood-damage area.

Effects of Works of Improvement

The proposed project would provide flood protection to irrigated cropland, farm homes, and farm improvements, residential areas now developed, roads, irrigation facilities, and future residential areas. The protection afforded will be from floods up to and including the 1 percent flood. In addition to providing protection to the damage area both now and in the future, there will also be protection from flooding on areas which could not develop without the project. Approximately 763 acres of rangeland now idle and relatively unproductive will be enhanced in value and will change to residential development areas as a result of the project.

The installation of the project will improve the over all economic activity in the watershed and adjacent area by promoting the growth and utilization of natural resources. In addition, other benefits can be measured in utilization of unemployed and underemployed labor in the area.

The installation of the planned structural measures will reduce the evaluated flood damage by approximately 98 percent. Floodwater damage will be reduced by 99.5 percent and the reduction in sediment damage will be reduced by approximately 94 percent.

The project, when installed, will directly benefit 2,070 acres of irrigated land, approximately 1,500 acres of non-irrigated land in miscellaneous uses such as residential areas and commercial areas. It will also enhance the value of 763 acres of land for future residential development.

Approximately 750 farm owners and 1,750 non-farm owners, or a total of 2,500 persons living in the watershed, will be benefited by the project.

Project Benefits

Primary Benefits - Both flood damage reduction benefits and changed land use benefits will accrue from the installation of the structural measures. Average annual damage reduction benefits are estimated to be $75,474 under future conditions of development in the watershed. Average annual damage reduction benefits of $75,474 include $54,673 direct floodwater damage reduction benefits, sediment damage reduction benefits of $11,547, and $9,204 reduction in indirect damage.

Benefits which will accrue from changes in land use are substantial. The areas protected by the proposed project on which a change in use is expected are located near present developing areas. The protection the project will give to the land below floodwater diversions 1 and 2 will make possible the development of residential areas.

The change in use on these lands was projected over a 15-year period of development. The projection was based on present trends of residential expansion in the watershed and population projections for the Albuquerque metropolitan area.

The estimated average annual benefits from changed land use are $64,746 (table 6). These benefits were evaluated on 763 acres of land changing in use from rangeland to residential development. Associated cost of the development and discounting of the benefits for a time lag of 15 years were taken into account in arriving at the values used in project justification.

Secondary Benefits - Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation and were not evaluated. Increased farm income and local business activity resulting from the installation of the project will be realized not only locally but also in the general trade area. Secondary benefits are significant at the local level and were used for project justification. Average annual secondary benefits which will accrue from the installation of the structural measures are estimated to be $13,591 (table 6).

Redevelopment Benefits - Redevelopment benefits have been estimated on the amount of local unemployed and underemployed labor which the construction and operation and maintenance of the structural measures will employ.

The basis for determining that unemployment and underemployment existing in the project area is found in published data for Bernalillo and Sandoval Counties by the Employment Security Commission of New Mexico. Other data to support the need and opportunity for use of local labor in project activities is found in the Sandoval County Economic Development Plan.

The estimated average annual redevelopment benefit which will accrue from project installation and operation and maintenance is $21,941 (table 6). The redevelopment benefits used in project evaluation from operation and maintenance were calculated for a 25-year period following construction of the project.

Project Installation

The work plan proposed a 5-year installation period for the project. Federal assistance for carrying out the works of improvement described in the plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 stat. 666), as amended.

The Extension Service will assist the sponsoring local organizations with the educational phase of the program by conducting general information meetings, by press releases, and other means of getting information to landowners and property owners in the watershed.

Land Treatment Measures - Land treatment measures on irrigated cropland and on the rangeland will be established on private lands by landowners and operators. The Soil Conservation Service will provide technical assistance in the planning and application of land treatment measures to individual landowners through the two soil and water conservation districts.

Federal cost-sharing assistance in accordance with existing policies and procedures will be available from the Agricultural Stabilization and Conservation Service for carrying out the land treatment program.

Structural Measures - The Corrales Watershed District will assume the local responsibilities for the installation of the structural measures. These responsibilities are enumerated as follows:

1. Acquire and bear all costs for land rights needed for the floodwater retarding structure and the two floodwater diversions.

2. Let and service contracts for the construction of all structural measures.

3. Bear 50 percent of the construction cost of the box culvert to be constructed in Corrales Main Canal (structure 106) and 50 percent of the construction cost of modifying existing irrigation facilities on the lower end of Arroyo de las Calabacillas.

The Soil Conservation Service will assume the responsibilities for the installation of the structural measures as listed below:

1. Provide technical assistance in the preparation of detailed engineering surveys, plans, designs, and specifications on the structural measures.

2. Provide construction funds for site 2, floodwater diversions 1 and 2, and stream channel improvement on the lower end of Arroyo de las Calabacillas. The Service will also provide up

to 50 percent of the construction cost of the box culvert (structure 106) and 50 percent of the construction cost of modifying existing irrigation facilities included in the plan.

3. Provide technical inspection during construction, prepare contract payment estimates, make final inspection, certification of completion and other related work for all structural measures.

4. Cooperate with the sponsors, state, local, and federal agencies so the objectives of the project will be met.

Financing Project Installation

The Corrales Watershed District has authority under state law to levy assessments on real property within the watershed district, borrow such money as is necessary, and acquire needed land rights. The Watershed District will use the power of eminent domain to acquire land rights if necessary.

Federal financial assistance in carrying out the project will be made available to the local organization when the necessary land rights are obtained and federal funds are available. Federal funds are contingent on appropriations made under Public Law 566.

Provisions for Operation and Maintenance

The Corrales Watershed District will operate and maintain all structural measures planned for the project after installation is complete.

Representatives of the sponsoring local organizations and the Soil Conservation Service will make a joint inspection of the structural measures annually and after each major flood for three years following installation of each structure. Inspection(s) will be made to determine if maintenance work is required and, if required, when it will be accomplished. Inspections after the third year will be made annually by the sponsors and a report prepared by them. A copy of the report will be furnished to the Soil Conservation Service.

The Corrales Watershed District and the Soil Conservation Service will enter into a specific maintenance agreement prior to issuance of invitations to bid.

The average annual maintenance for all structural measures is estimated to be $4,886 (table 5).

Items to be considered in maintaining the structural measures include the conditions of the principal and emergency spillways, the earthfill and fences or by the floodwater retarding structure. The floodwater diversions will require removal of sediment deposits when needed to maintain the designated capacities, removal of weeds and debris, and maintenance of satisfactory outlets for the diversions into the Rio Grande.

Damage to structural measures can occur from floods larger than the design storms. Any damage to the emergency spillway of site 2 which can occur if the spillway operates and other damage to structures from floods will be a part of the operation and maintenance costs.

Comparison of Benefits and Costs

The average annual cost of the structural measures (amortized from total installation cost, plus average annual operation and maintenance cost) is $128,880 (table 5). The installation of the structural measures is expected to produce average annual primary benefits of $186,866. The ratio of primary benefits to costs is 1.4 to 1. The estimated total average annual benefits, including secondary benefits from the structural measures, are estimated to be $202,097 and will provide a benefit-cost ratio of 1.6 to 1 (table 6).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $14,200. The average annual returns are estimated to be $65,000.

Table 1, Structure data, Corrales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. height of dam (ft.)	Est. vol. of fill (cu.yd.)	Principal spillway Type	Principal spillway release rate (csm)	Emergency spillway Type	Emergency spillway % chance of use	Max. surf. area em. spwy. level (acres)	Structure class
2	36.8	52.1	671,667	RC conduit	8.7	earth	1	339	c

Table 2, Channel data, Corrales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach (100 ft.)	Watershed area (sq.mi.)	Needed ch. cpcty. (cfs)	Bottom width (ft.)	Depth (ft.)	Velocity in ch. (ft./sec)	Estimated vol. of excavation (cu. yds.)
Floodwater diversion 1	116	23.8	7280	25	10.3	28	conc. lined
Floodwater diversion 2	53	10.0	4159	28	10.25	14.49	conc. lined

Table 3, Reservoir storage capacity

Site number	Drainage area (sq.mi.)	Storage capacity planned: Sediment	Storage capacity planned: Detention	Storage capacity planned: Total
		- - - acre feet - - -		
2	36.8	1,213	2,807	4,020

Table 4, Distribution of structural cost - potential development, Corrales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and RW 2/	Administration of contracts	Installation cost
Floodwater retarding structure site 2	462,725	92,276	20,680	600	576,281
Floodwater diversion 1	1,097,342	221,892	85,299	1100	1,405,633
Floodwater diversion 2	515,491	105,748	47,360	1200	669,799
Total	2,075,558	419,916	153,339	2900	2,651,713

1/ Price base: 1969

2/ Includes the following: land, easements, and rights-of-way \$103,165; land rights survey \$1,500; flood easements for floodwater diversions 1 and 2 \$22,145; site 2 flowage easements \$3,030; bridge (State Road 46) \$6,000, bridge for maintenance road \$4,680; bridge for gas line road \$4,590; and gas line modification \$1,200.

Table 5, Annual cost, Corrales Watershed, El Rio en Medio Watershed, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Montoya-Las Negras Arroyos			
Evaluation Unit 1			
Floodwater retarding structure, site 2			
Floodwater diversion 1	92,674	3,549	96,223
Black's Arroyo			
Evaluation Unit 2			
Floodwater diversion 2			
Stream channel improvement on Calabacillas Arroyo	31,320	1,337	32,657
Total	123,994	4,886	128,880

1/ Installation cost based on 1967 prices, amortized for 100 years at 4 5/8 percent interest

2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Corrales Watershed, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Average annual benefits 1/					Average annual cost	Benefit-cost ratio
	Flood Prevention						
	Damage reduction	Changed land use (urban)	Redevelopment	Secondary	Total		
Arroyos de los Montoyas and las Negras - Evaluation unit 1 Floodwater retarding structure, site 2, and floodwater div. 1	58,401	44,432	22,690	9,926	135,449	96,223	1.4:1
Black's Arroyo - Evaluation unit 2 Floodwater diversion 2 and channel improvement on Calabacillas Arroyo	17,073	36,720	7,550	5,305	66,648	32,657	2.0:1
Total	75,474	81,152	30,240	15,231	202,097	128,880	1.6:1

1/ Price base: adjusted normalized prices

2/ from table 4

LEGEND

FLOODWATER RETARD STRUCTURE
STREAM CHANNEL IMPROVEMENT
LEVEE OR DIKE
FLOODWATER DIVERSION
1c GRASSLAND MGT.
2b PINYON-JUNIPER MGT.
3bl SAGEBRUSH MGT.
5 BOTTOMLAND VEGETATION MGT.
6a IRRIGATED LAND MGT.
8 CRITICAL EROSION AREAS

PAVED HIGHWAY
SECONDARY ROADS
CANAL
HOUSE
PIPELINE

Scale
2 1 0 1 2 3 4
Miles

STRUCTURE LOCATION
AND
LAND TREATMENT MAP
CORRALES WATERSHED
UPPER RIO GRANDE BASIN

DEFINITIONS LAND TREATMENT SYSTEMS

1. Grassland Management Area - (Potential benefits include increased forage production, reduction in sediment yield and increased water yield.)

   1b. Snowpack Management - This treatment system applies to open grassland at elevations above 10,000 feet. Snowfall is managed by constructing barriers (vertical slat snow fence) of appropriate height and spacing to create drifts, thus reducing evaporation caused by wind action. Bush-type vegetation can be planted to eventually replace the barriers.

   1c. Good Range Management - This treatment system includes the remainder of the open grassland not in 1b or 8. Benefits can be expected by using better than average range management. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, and better livestock distribution through use of fencing and water locations.

2. Grazable Woodland Management Area - (Potential benefits include increased forage production for livestock and big game, limited wood products, and reduction in sediment yields).

   2a. Pinyon-juniper Control - This treatment system applies to grazable woodland areas with moderately deep and deep soils on moderate slopes. Treatment includes tree and brush removal and the proper combination of practices as shown in 1c or 8 based on the need for either critical area managment or good range management and wildlife habitat protection or improvement.

   2b. Ponderosa Pine-Pinyon-Juniper Management - This treatment system applies to the non-commercial ponderosa pine (under 45 site index) and the remaining pinyon-juniper areas. Treatment includes selective thinning and spot clearing of woody vegetation, needed good range management practices as shown in 1c, and wildlife habitat protection or improvements.

3. Brushland Management Area - (Potential benefits include increased forage production for livestock and big game and a reduction in sediment yield. An increased water yield may be expected on brush land at high elevations.)

   3a. ___________brush Control - This treatment system applies to all _________brush covered land on topography and soils suited to _________brush clearing methods. Depending upon type of brush treatment, includes plowing and seeding, burning and seeding, shredding or spraying, grubbing and stacking of brush followed by the proper combination of practices as shown in 1c or 8 as

based on the need for critical area management or good range management and wildlife habitat protection or improvement.

3b. ____________brush area management - This treatment system applies to all ________brush land on which brush control is unnecessary or undesirable. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, better livestock distribution through use of fencing and water locations, and wildlife habitat protection or improvement.

4. Commercial Timber Management Area - (Potential benefits include increased water yield, timber harvest, and forage production for livestock and big game.)

4a. Spruce-Fir Management Area - Treatment system applies to all spruce-fir and mixed conifer stands suitable for treatment. Treatment includes the proper combination of the following practices: block and strip cutting for spruce-fir and selective cutting for mixed conifer, thinning, tree planting, fire protection, proper grazing use, and wildlife habitat.

4b. Ponderosa Pine Management - Treatment system applies to all commercial ponderosa pine (over 45 site index) stands suitable for treatment. Treatment includes the proper combination of the following practices: harvest cutting, thinning, pruning, tree planting, seeding grass, proper grazing use, fire protection, and wildlife habitat protection or improvement.

4c. Aspen Management - Treatment system applies to all aspen stands suited to management for regrowth of aspen. Treatment includes the proper combination of practices necessary to provide for proper grazing use and wildlife habitat protection or improvement.

5. Bottomland Vegetation Management Area - (Potential benefits include increased water yield and forage production.)

5a. Phreatophyte Control - Treatment system applies to all areas invaded by undesirable woody vegetation. Treatment includes the proper combination of the following practices: clearing, thinning, shredding, spraying, reseeding to adapted grasses, and proper grazing management.

5b. Bottomland Management - Areas on which it is desirable to maintain some woody vegetation cover for recreation, wildlife habitat and aesthetic purposes.

6. Crop, Pasture, and Hayland Management Area - (Potential benefits include savings of water, reduction in sediments, and increased crop and forage yields).

6a. Irrigated Land Management -- Treatment system applies to all irrigated land. Treatment includes the proper combination of all the following practices: conservation cropping systems, pasture and hayland management, timely tillage, irrigation water management, and the following:

6a1. Drainage - Practice involves reclamation of land subject to a crop inhibiting water table.

6a2. Improved Farm Irrigation System - Practices include realigning irrigation canals, laterals, and field ditches, ditch lining, irrigation pipelines, sprinkler systems, land leveling, and tail water recovery facilities.

6b. Dryland Management - Treatment system applies to all dry crop, pasture, and hayland. Treatment includes the proper combination of the following practices: conservation cropping systems, contour farming, diversion terraces, proper residue management, pasture and hayland planting or renovation, and pasture and hayland management.

6c. Abandoned Cropland Management - Treatment system applies to all permanently idle land that was previously cropped. Treatment includes the proper combination of the following practices: reseeding with adapted grasses, trees or shrubs, small gully control, water-spreading devices, grazing land mechanical treatment, and the needed good range management practices listed in 1c.

7. Miscellaneous Land - Land from which few, if any, economic benefits can be expected from land treatment. Included are inaccessible areas (very steep land) and non-productive land (rockland, river wash, water areas, badlands, cities, towns, roads, airports, farm sites, and other cultural areas).

8. Critical Erosion Areas - (Potential benefits include - sediment and wind damage reduction and increased forage yields.) This treatment system applies any place where special methods are needed to reduce erosion and to restore the area to productive use. Treatment includes the proper combination of the following practices: livestock exclusion or limited livestock use, small gully control, water-spreading devices, grazing land mechanical treatment, fencing, intensive vegetation management and critical area seeding.

Table of population , El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

Year	Population increase			Total population in basin		
	Cities greater than 100 population	Communities smaller than 100 population and rural	Total	Cities greater than 100 population	Communities smaller than 100 and rural	Total
1970	64,378	611	64,989	400,791	31,145	431,864
1980	165,710	1,979	167,689	566,429	33,124	599,553
1990	190,968	1,941	192,901	757,397	35,065	792,462
2000	238,849	2,835	241,684	996,246	37,900	1,034,146
2010	289,862	3,249	293,111	1,286,108	41,149	1,327,257
2020	341,660	4,144	345,804	1,627,768	45,293	1,693,061

Table of water and sewerage needs, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

	1970	1980	1990	2000	2010	2020
Total water and sewerage development needs (new and expansion)	40,322,900	59,723,136	67,903,968	85,072,768	103,175,072	121,723,068
Water and sewerage development needs for communities greater than 100 people	40,107,828	59,026,528	67,220,736	84,074,848	102,031,424	120,264,320
Water and sewerage development needs for communities less than 100 people and rural	215,072	696,608	683,232	997,920	1,143,648	1,458,688
Federal cost share potential FHA under PL 660 - up to 30%	1,757,815	1,436,743	1,312,819	1,216,934	1,785,801	1,387,900
State of New Mexico cost share up to $12,000 per community	240,000					
Total cost to local people for their share of water and sewerage development	38,325,085	58,286,392	66,591,149	83,855,834	101,389,271	120,335,108
Total cost to people of communities greater than 100 people	38,110,013	57,589,785	65,907,917	82,857,914	100,245,623	118,876,420
Total cost to people of communities less than 100 people and rural	215,072	696,608	683,232	997,920	1,143,648	1,458,688

Table of water needs and consumptive use - power, El Rio en Medio Subbasin, Upper Rio Grande Basin, New Mexico

	1965	1970	1980
Municipal and rural domestic water needs (gallons/day)	47,630,951	63,761,857	109,542,702
Municipal and rural domestic water consumptive use (gallons/day)	24,129,925	37,814,876	66,483,709
Relationship of rural domestic & municipal water needs to power water needs	3.239	3.946	5.359
Relationship of rural domestic & municipal water consumptive use to power consumptive use	0.118	0.139	0.177
Projected power water needs (gallons/day)	154,276,650	251,604,288	587,039,340
Projected power water consumptive use (gallons/day)	2,847,331	5,256,407	11,767,616

Table of water needs and consumptive use - industrial, El Rio en Medio Sub-basin, Upper Rio Grande Basin, New Mexico

	1965	1970	1980
Municipal and rural domestic water needs gallons/day	47,630,951	63,761,857	109,542,702
Municipal and rural domestic water consumptive use gallons/day	24,129,925	37,815,176	66,483,709
Relationship of rural domestic and municipal water needs to industrial water needs	1.778	1.879	2.080
Relationship of rural domestic and municipal water consumptive use to industrial consumptive use	0.547	0.530	0.495
Projected industrial water needs gallons/day	84,687,831	119,808,529	227,843,820
Projected industrial water consumptive use gallons/day	13,199,069	20,042,414	32,909,436

IRRIGATION DITCHES IN THE EL RIO EN MEDIO SUBBASIN

	Approximate acres served
Diversions from Nacimiento Creek	
Lagunitas Community Ditch	192
Domingo Vigil Ditch	80
Ramon Garcia Ditch	30
Francisco Chavez Ditch	140
Nacimiento Ditch	400
Ballejos Ditch	25
M. Atencia Ditch	40
Copper City Ditch	100
Diversions from Rito Leche Creek	
Lower Rito Leche Ditch	40
Upper Rito Leche Ditch	60
Diversions from Rio Puerco	
Vallecitos Ditch	100
Rio Puerco Ditch	100
Ortiz Ditch	7
Garcia Lucero Ditch	400
Diversions from Rito los Pinos	
Los Pinos Ditch	200
Diversion from La Jara Creek	
La Jara Ditch	871
Diversion from San Jose Creek	
San Jose Ditch	300
Diversion from San Antonio Creek	
Abousleman-Hofheins Ditch	65
Diversions from Jemez Creek	
West Side Ditch	21
Sandoval Ditch	12
Jemez Springs Community Ditch	100
Lower Canones Community Ditch	10
San Ysidro Community Ditch	1,071

IRRIGATION DITCHES IN THE EL RIO EN MEDIO SUBBASIN (Continued)

	Approximate acres served
Diversions from Guadalupe Creek	
G. Trujillo Ditch	20
Canones Community Ditch	296
Diversion from Paliza Creek	
Ponderosa Community Ditch	1,100
Diversion from Rio Grande	
Middle Rio Grande Conservancy District	81,011
Diversion from Las Huertas Creek	
Placitas Community Ditch	500
Diversions from Cuchillo Creek	
Cuchillo Community Ditch	393
Diversion from Las Palomas Creek	
Las Palomas Community Ditch	495
San Miguel Community Ditch	150
Diversion from Alamosa Creek	
Monticello Community Ditch	670
Diversion from Bluewater Creek	
Bluewater-Toltec Irrigation District	5,488
Diversion from Seboyetta Creek	
Seboyetta Irrigation System	190
Diversion from Bibo Creek	
Bibo Irrigation System	220
Diversion from Water Canyon	
Cubero Irrigation System	250

	Approximate acres served
Diversion from San Jose Canyon	
San Fidel Irrigation System	200
Diversion from San Mateo Springs	
San Mateo Irrigation System	50
Diversion from Juan de Tafoya Canyon	
Marquez Irrigation System	165